UM2B

(Recovery voltage Meter)

User manual

CE

Read this manual before using the equipment.
Keep this manual with the equipment.

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PROLOGUE

This instructions manual contains all the information required to start-up and maintain the UM2B metering system. The objective is to provide all the information required for a correct operation.

IMPORTANT: Read the entire instructions manual before starting up the UM2B unit.

The information contained in this manual is considered to be as accurate as possible. In any case, UNITRONICS will accept no responsibility for direct or indirect damage arising as a result of misinterpretation, inaccuracies or omissions therein.

SYMBOLS

DANGER: This symbol indicates a highly dangerous procedure that might cause serious damage to the equipment or to persons, or even death, if not correctly performed.

ATTENTION: This symbol indicates a dangerous procedure that might cause serious damage to the equipment or to persons if the appropriate precautions are not taken.

ISO9001

UNITRONICS, S.A.U. is an ISO9001 certified company.

CE

The equipment meets the requirements of the EU Directives.

UM2B. Recovery Voltage Meter

User Manual

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GUARANTEE

All equipment produced by UNITRONICS has a standard warranty period of 12 months as from the date of delivery to the customer.

The warranty is against defects in materials and workmanship. UNITRONICS' obligation shall be to repair or replace defective products within the warranty period. The warranty covers the equipment. It does not cover accessories such as cables, etc.

In order to benefit from this warranty, the purchaser should inform UNITRONICS or his closest representative (see section 8) of the defect prior to the completion of the warranty period.

This warranty does not cover any defect, fault or damage caused by misuse or inadequate maintenance by the purchaser, nor non-authorized modifications or use outside the specifications. Neither does it cover faults caused by natural disasters, including fire, flood, earthquake, etc.

Any opening of the equipment, modification, repair or attempt to repair performed without authorization shall invalidate this warranty, which shall automatically be left void.

This warranty is effective only for the original purchaser of the product and is not transferable in the event of resale.

Warranty extensions and maintenance contracts are available for both the hardware and software. Please ask for information from the commercial department of your nearest representative (see section 8).

1.- INTRODUCTION

This unit has been especially developed to facilitate the measurement of recovery voltage in dielectrics. This measurement is especially significant in the case of transformer dielectrics, where the equipment provides an interpretation of the possible degree of humidity in the insulation and its evolution with time. In paper-oil dielectrics, the quality of the insulation is influenced to a large degree by it's humidity content. In any case, the unit is capable of evaluating the status of dielectrics of all types, both in rotating machines and in transformers, cables and other devices.

Gaining insight into the status of transformers is a complex problem. For this reason, different techniques have been developed, allowing in-depth studies to be performed on the different parts into which transformers may be divided.

One of the methods used consists of measuring the recovery voltage of transformers, this allowing problems such as the following to be detected:

- degradation of solid dielectric
- degradation of liquid dielectric
- contamination of the insulation

Almost all these methods have a peculiarity: the absolute values of the parameters measured are not usually sufficiently indicative for the results to be evaluated. Rather, it is their evolution that provides the best information on the status of the winding, as a result of which it is particularly useful for the results to be memorized and incorporated into databases for correlation.

This leads to the definition of a **predictive maintenance** policy consisting of the scheduling, at a suitable frequency, of a series of routine and easily performed tests that provide sufficient information on the evolution of the assembly through the analysis of certain parameters. When these analyses detect rapidly evolving situations, or when average values considered to be potentially hazardous are reached, other more complex testing techniques will be applied, which may imply the unavailability of the machine for long periods or even some risk for the integrity of the winding.

The objective of this type of maintenance is to gain accurate insight into the actual status of the equipment or component and, depending on its condition, to determine what course of action would be most appropriate: continue normal operation, impose certain limitations, undertake service or repairs or, finally, undertake replacement. In other words, the aim is not only to limit unnecessary actuations but also to complete the information available on the actual status of the equipment, such that suitable decisions may be taken.

Predictive maintenance is applied successfully and with the greatest frequency to major items of equipment subjected to complex ageing or degradation phenomenon and on which a large number of variables act. In most of these cases there is no formula available allowing the status of the equipment to be estimated, as a result of which tests are required to obtain the values of different significant parameters and, on the basis of these, to undertake interpretation.

Consequently, start-up goes hand in hand with the definition and performance of tests and the interpretation of their results. For the first, it is necessary to have in-depth knowledge of the equipment and techniques involved, while for the second there is a need for specialist technical personnel.

As a complement to the UM2B unit and it's associated software of Recovery Voltage measurement, it exists a software application for Insulation Resistance measurement. This application will allow us to carry out a quick evaluation of the machine insulation test without executing Recovery Voltage software.

2.- DESCRIPTION OF MEASURING METHOD

2.1.- Philosophy of the method

The UM2B is an automatic system designed to determine the recovery voltage of transformers. It is designed to be a predictive maintenance system, for which it meets the following requirements:

- *Automatic measuring system*. In order to avoid errors due to acquisition times, manipulation and corrections caused by the ambient conditions and the conditions of the machine at the moment of measurement.
- *Repeatability of the measures*. The system warranties that the readings obtained over time have been acquired in the same way and under the same degree of accuracy and tolerance. This will allow the evolution of the readings to be studied.
- *Automatic and organized storage of results*. This allows the information obtained to be handled in a very simple manner.
- *Updateable system*. The system has been developed such that whatever new software development might arise, it may be implemented with the same hardware elements.
- *Acquisition of key parameters*. The system automatically calculates certain parameters and graphics for the diagnosis of machine status.
- *Non-destructive testing*. If suitably handled, there is no risk of damage to the winding during testing.

2.2.- Test characteristics

The test to be used should be performed, with a view to the following:

- The tests should be easy to perform, allowing for performance by suitably trained personnel from the facility, without the need for specialists.
- The tests should not imply any risk for the equipment to be tested.
- The tests should not imply excessive unavailability (and if possible none).
- The data and results obtained should offer at least some information allowing the operator performing the test to make an immediate interpretation.
- The set of data obtained should allow for storage on data-processing media, such that they be simple to transmit for in-depth study by specialists, who will obtain the maximum information from the data acquired and take the appropriate decisions through comparative studies with other cases.

2.3.- System behavior and important parameters during measurement

The UM2B unit is designed to output a direct current voltage of up to 2 kV to the element to be tested, carry out the loading and discharge intervals on the dielectric as described for the specific test and, finally, measure the voltage and current.

The unit will examine the status of the dielectric of the equipment being tested, as shown electrically in figure 2.1. The different elements in this figure are as follows:

- **Cg**, Geometric capacity of the equipment being tested. This will be determined by the physical characteristics of the armatures of the equivalent condenser, surface, properties of intermediate dielectric and separation between armors.
- **Ra**, Insulation resistance. In measuring, this is related to the final leakage current following the transitory loading period of the dielectric.
- **Rpx and Cpx** are the electrical elements used to describe the recovery voltage characteristic. In an equivalent circuit there will be a multitude of such elements, in order to reflect the distributed nature of this behavior.

The test to be performed aims to determine the equivalent time constants Rp/Cp, the measure and evolution of which are determining factors as regards the current and future status of the dielectric. The test consists of inserting over a time T a previously established voltage of up to 2 kV. Following this time, a short-circuit is performed on the sample for a time T/2, and finally the evolution of the recovery voltage appearing is recorded. This process (cycle) is repeated for multiples of T, and the maximum recovery voltages associated with each interval or cycle are used to graph a curve on which would be shown in a T time axis of application and maximum tension in the other axis. Above the mentioned dots a fitting curve is drawn. Then, each time constants Rp/Cp should appear as a maximum on the graph.

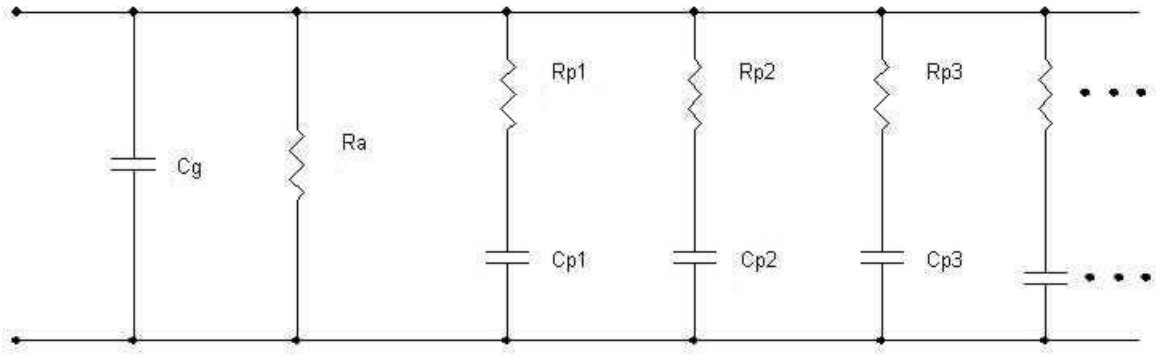


Figure 2.1: Dielectric equivalent circuit.

When a high voltage generator DC voltage is applied to a dielectric, the current across the insulation shows the following behavior, as plotted in figure 2-2.

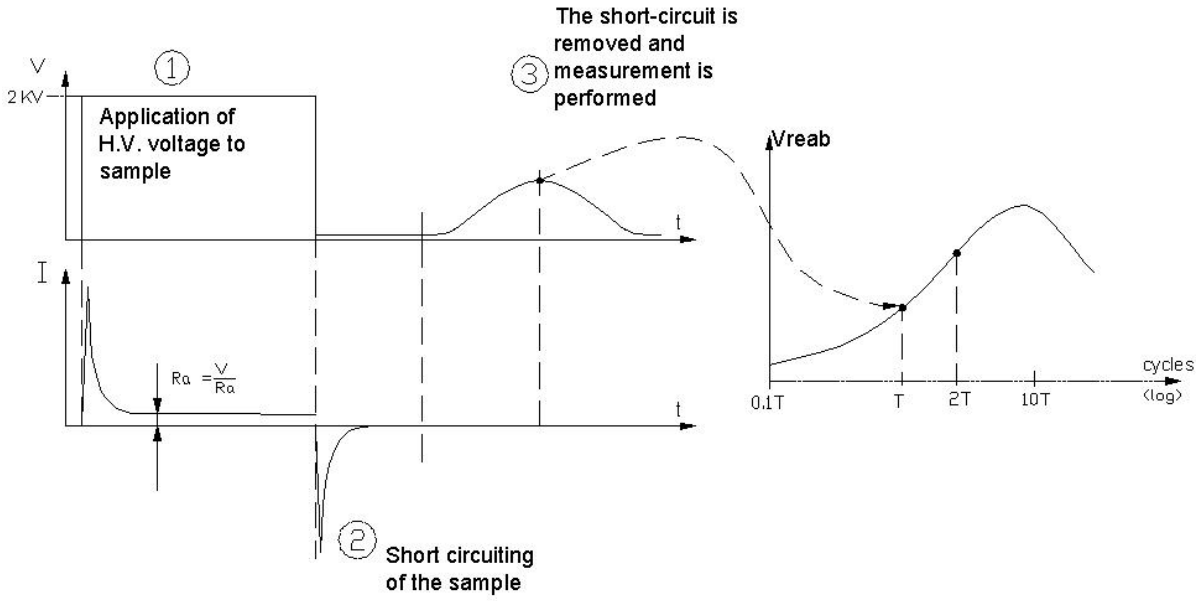


Figure 2-2: Description of the test procedure.

1) **Application of H.V. voltage to the sample**. The current starts with a high value that gradually decays with time and finally remains stable. The low initial insulation resistance is caused in part by the high initial loading current of the associated condenser Cg. This capacitive current rapidly decays to a low value as the insulation is charged. Furthermore, the low initial insulation resistance is caused by another phenomenon, which is the dielectric absorption current, Rp/Cp. This current also decreases with time, albeit more gradually, until it reaches an insignificant value. The final leakage current does not change with the time of voltage application, and is a fundamental parameter for judging the insulation, this is Ra. The insulation resistance varies directly with the thickness of the insulation, and inversely with the area tested.

2) **Short-circuiting of the sample**. At this moment the current is initiated with a high value in inverse direction to the period before corresponding to the rapid discharge of Cg, while Ra does not actuate due to the short-circuit having a lower resistance. There will be a weak current associated with the discharge of the Cp's across the Rp's, but the most likely thing will be that if the short does not last too long, these Cp's will maintain part of their charge.

3) **The short-circuit is removed and the measurement performed**. During this phase, and with the Cp's remaining charged, if the voltage is recorded at the terminals of the sample, the Cp's will be observed to charge the capacitor Cg across the Rp, and finally both will discharge via Ra. This gives a curve with a maximum that, as commented before, is the one registered for every cycle.

For the measurement to be performed under optimum conditions, there are certain details that should be taken into account:

Conditions of the surfaces. Any dust accumulating on the surface of the sample tested may alter insulation resistance measurements if there is associated humidity, for example in the case of rainfall.

Temperature. The resistance of insulating materials changes with temperature. Consequently, the result of a test will be comparable to that of another only if both are performed at the same temperature. For this purpose, it is habitual to refer tests to certain reference temperatures, with the appropriate correction parameters, in order to allow for comparison. It is of interest that the tested machine has his temperature stabilized (let settle after switched off from service) and his temperature be measured from the inside with appropriate accuracy. Temperature has a large influence in dielectric evaluation as insulation resistance is directly related to temperature variations. To figure out, each 10ºC of thermal increment for the same increment to the same dielectric, his resistance is halved.

Test voltage. Insulation measurements will be performed at test voltage values agree with the working voltage of the machines to be tested, in order not to cause degradation to their insulations.

Previous charge effect. A factor that affects insulation and dielectric absorption measurements is the preliminary presence of a previous charge in the insulation. This charge may come from the normal operation of a generator with its neutral not grounded or from previous insulation resistance measurements. A lot of time may be saved if the generator winding is grounded until such time as the test is to be performed. The duration of this grounding should be around four times the charge period of the previous test.

Measuring cables. In view of the weak currents involved in the measurement and its special characteristics, it is important to take into account the following as regards the cables:

- Do not tread on cables or knock or move them during testing.
- Locate the cables extended, without bending or folding, as close as possible and in parallel throughout their entire length.
- Should be in perfect condition and checked for use.

2.4.- ETPRA. Data interpretation

It follows interesting details if you have available the Insulation Resistance Measurement Software (ETPRA).

From the exam of the circuit of figure 2-1, it states that to discharge Cg, you only need to short-circuit the dielectric terminals, but to discharge Cpx, it will be required a time proportional to the time constant **Rpx*Cpx**. This means to say that if a transformer has not been phase-grounded the required time to discharge that Cpx, it will exist some residual charge that make hard to compare consecutive test of Insulation Resistance performed in the dielectric.

The software developed for UM2B unit accounts for this effect and let you perform a discharge period previous to the test, that will make consecutive test easy to exactly compare. Anyway, in some case it could be appreciated slight differences between the insulation measurement performed with the Recovery Voltage software and the one performed with the Insulation Resistance software (ETPRA). This is due to that the Recovery Voltage measurement software uses one of the charging cycles longer than 10 minutes to measure insulation. In this software the discharge conditions of that Cpx have been restricted enough not to make the test last too long and give accurate results. This limit could offer slight measurement differences between both applications.

It is therefore recommendable to begin the test with the unit UM2B after having shorted the machine to test. If it had been made previous test, that short should last at least around four times the charge time of the last test.

3.- UM2B EQUIPMENT

3.1.- Description of the product

The UM2B unit has been especially designed to determine the recovery voltage of single and/or three-phase transformers and autotransformers of any type. It is based on the measurement of a series of simple parameters by means of a data acquisition system and a computer application for the performance of calculations.

Figure 3-1: Appearance of the measurement system.

Once the data have been obtained, enough information is available for diagnosis of the current status of the transformer, and for assessment of the trend curves. The advantages that characterize the UM2B method may be summarized as follows:

- minimum risk for the machine.
- reduced unavailability times.
- simple performance.
- high degree of test automation.

3.2.- System elements

The equipment may be fitted with the following elements and / or accessories:

*NOTE: The **XX** nomenclature indicates different versions, depending on the characteristics of the equipment. Please consult with your sales person.*

REF No	DESCRIPTION
UM2BXX	UM2B measuring equipment with serial number.

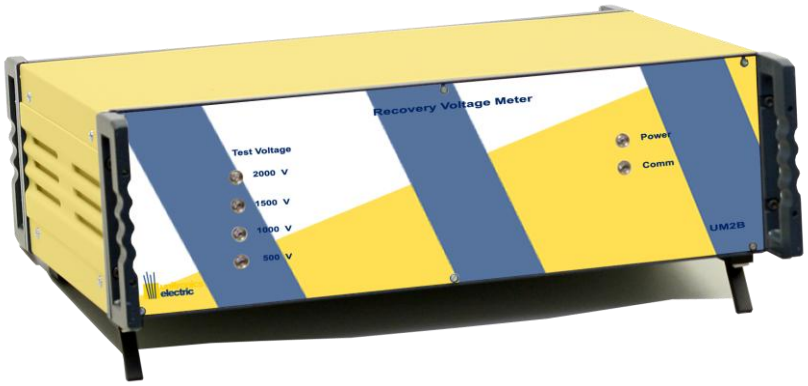


Figure 3-2: Measuring unit.

BEL00	Measuring equipment transport bag.

Figure 3-3: Transport bag.

CR00	Mains supply cable with ground terminal.
CRS23200	Shielded series cable with DB9 terminal connectors for communications between the PC and the unit. The cable **must be shielded.**

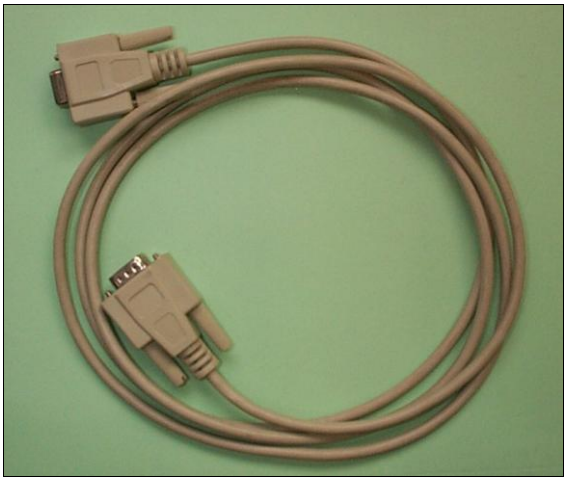


Figure 3-4: Serial cable.

M8AT0L	8-metre long high voltage shielded measuring cables with wide opening clip pincers at one end and high voltage connectors at the other. The polarity is indicated by the color of the clips and connectors: red for positive and black for negative. **These must be shielded.**

Figure 3-5: High voltage cables with power clips.

BCL00	Cable transport bag

Figure 3-6: Transport bag.

SOFUM2BRBWXXX	1CD with equipment control software.
UM2BMUXX	The present user manual.
RAFVDM00	Four power sockets protected against voltage surges, differential currents and overcurrent. This incorporates a voltmeter for direct verification of the supply voltage indicator of ground connection and terminals for ground connection.

Figure 3-7: Power Socket.

MM00	Rigid transport case with reinforced external protection and internal padded lining of high-density foam rubber.

Figure 3-8: Transport Case.

3.3.- Physical description of equipment

Figure 3-9 shows a drawing of the UM2B unit, the upper part corresponding to the front panel and the lower to the rear panel. The function of each element of the unit is described below.

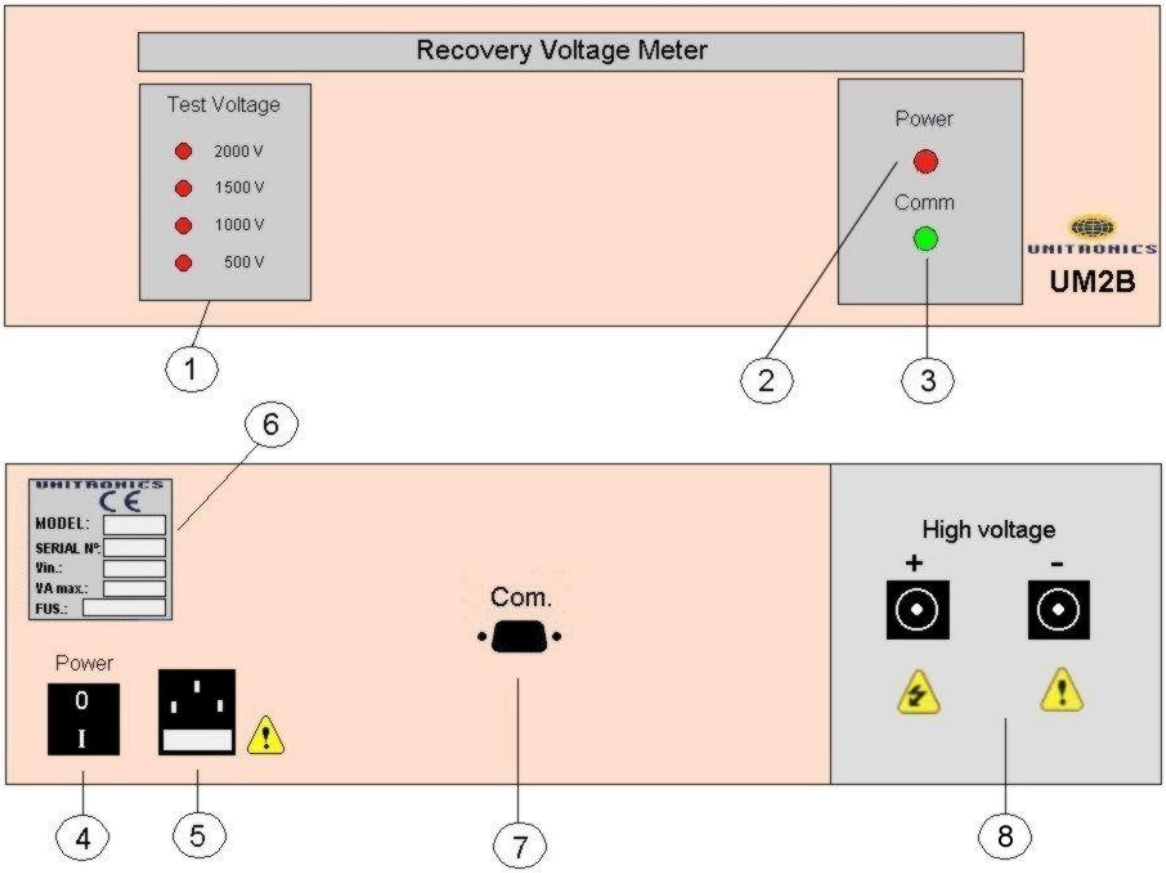


Figure 3-9: Front and rear panel of the unit.

1	Test voltage indicator. This acts as a voltmeter, indicating the voltage being applied to the machine by means of 4 LED diodes.
2	Power unit connection indicator. This should light up when the power switch (4) is turned on.
3	Luminous indicator of communications with the PC.
4	Equipment connection switch. This is operated to connect the equipment to the electrical mains when the PC software so indicates.
5	Mains input connection. This includes a fuse-holder and a spare fuse.
6	Unit nameplate.
7	PC communications connector.
8	Connectors for high voltage cables running to equipment being tested.

The rest of the indicators / warnings appear on the computer screen and will be described in detail in chapter 5 (*Software description*).

4.- PREPARATIONS BEFORE TO USE

The UM2B equipment is an automatic, high performance system especially designed for the assessment of transformer recovery voltage parameter. For performance of the measurement, the system provides high voltages (up to 2000 Volts d.c.) during testing, this possibly implying serious danger for the equipment operator if the system is handled incorrectly.

Consequently, **IT IS CONSIDERED ESSENTIAL THAT THE OPERATOR IN CHARGE OF HANDLING AND MAINTAINING THE EQUIPMENT RECEIVE TECHNICAL TRAINING**.

Likewise, all persons performing or witnessing a test should take the necessary safety precautions, in order to avoid any contact with the parts to be analyzed or forming part of the measurement system, remaining at some distance from them unless these parts are free from voltage and grounded.

Measurements performed using the UM2B system are carried out OFF-LINE. Consequently, prior to beginning the test, THE SYSTEM SHOULD BE VERIFIED TO BE FREE FROM VOLTAGE/LOAD.

If the equipment is damaged during the warranty period as a result of inappropriate use, without following the instructions described in this chapter, the repair may be excluded from the warranty.

4.1.- Precautions in the area of installation

When this instrument is used to test high voltage machines, all the habitual safety procedures and standards applicable to this type of machines should be adhered to. Ensure in all cases that the equipment being tested is completely discharged and grounded before touching it.

For the safety of the equipment operators or any other worker in the area, as well as for the integrity of the system itself and to ensure that the measurement results are valid, a series of precautions should be taken at the test location. These may be summarized as follows:

- Check that the surrounding area is appropriate (without rain or dust storms) and that it is within the temperature / humidity margins specified for the operation (see chapter 9: Specifications).

Check that the system supply voltage is within the specific operating limits (see chapter 9: Specifications) and that it is grounded. This ground should match with that of the equipment being tested. In case of doubt, the best thing is to run a thick plaited grounding cable from the system supply to the equipment tested.

- Check that the equipment to be tested is free from its operating voltage or any remnant voltage (it is most advisable for the machine to have been in a previous short circuit state before the test).

- Position the measuring unit and the control computer close to the equipment being tested, as shown in Figure 4-1.

- Isolate the test area by means of the necessary mechanical elements, as homologated by the safety department of each company, such as cones, fencing, safety tapes of different colors located at waist height, etc.

4.2.- Equipment connection

In view of danger that this equipment misuse might entail, **ALWAYS ADHERE TO THE SEQUENCE DESCRIBED BELOW.**

For the performance of a test, the measuring unit and control computer should be located close to the equipment to be analyzed, as shown in Figure 4-1. To start up the equipment, carry out the following instructions in the order presented (the different elements of the panels in Figure 3-9 are referred to in brackets):

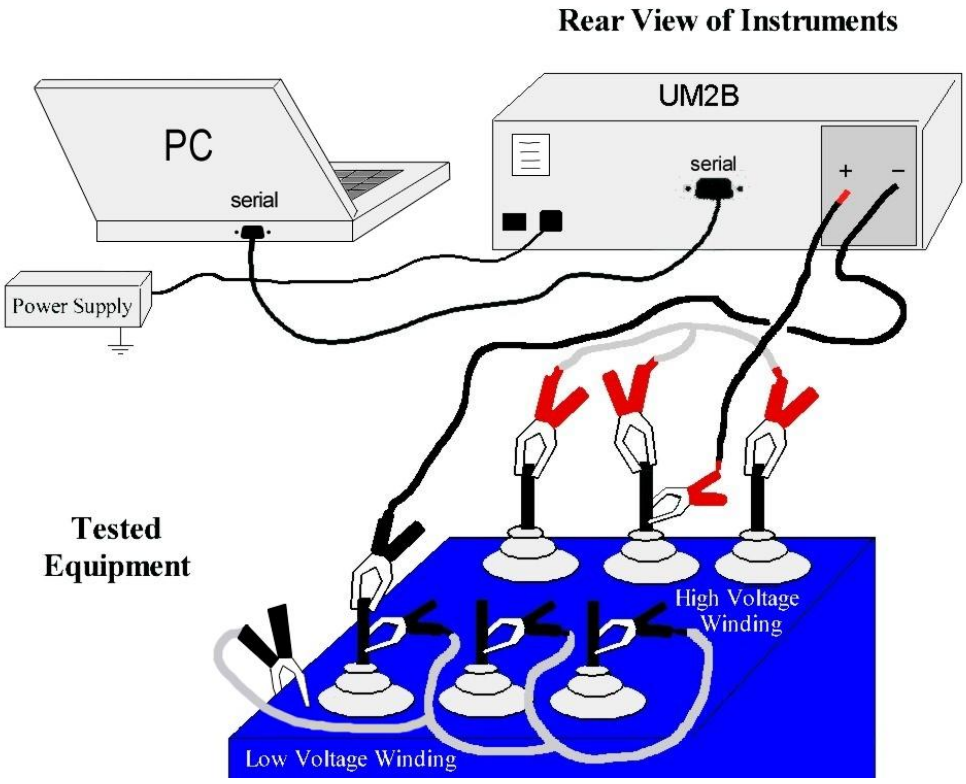


Figure 4-1: Disposition of the test elements.

- Connection of PC to UM2B.

  This connection is accomplished with the series cable, connected to the serial communications port of the PC.

- Safety check.

  The equipment to be measured should be checked to ensure that it is duly isolated from the external connection lines and completely discharged.

- Connection of high voltage cables to UM2B.

  The high voltage cables should first be connected to the unit (8). Next, choose measurement configuration to perform test. The phases of each winding (high/low) will be put on short circuit. The phases may be interconnected by means of bare copper wire if the distances are short and there is no risk of short-circuiting to ground; otherwise, a proper insulating cable should be used. Finally, connect positive / negative terminal according to software indications.

Never remove high voltage connectors during test.

Figure 4-2: Configuration of the test.

V max.: **2000 V dc**
I max.: **5 mA**
Installation: **CAT II**

For properly measuring, the cables must be completely stretched until the measurement point without creases, or anyway, that these have a radius not under 200 mm.

While measuring, the cables must not be stepped, moved or hit, because the measurements could be altered, specially when measuring high-quality insulations, due to the piezoelectric effect of the cable and the weak measured currents. If it is possible, put these cables parallel and nearest between them to avoid interferences.

If the shell of the machine to be analyzed is grounded, a check should be made to ensure that this is the same ground as the one of the PC supply and the measuring unit. To accomplish this, join these two points with a plaited cable of adequate cross-section. **ALL THE GROUNDS USED IN TESTING SHOULD BE INTERCONNECTED**.

- Connection of UM2B equipment to electrical mains.

  This connection is accomplished by running the power cable from (5) to a mains socket. The supply voltage should be checked to ensure that it is within the operating limits (see chapter 9: Specifications) and a check should made to ensure that the socket has an operative ground.

Once the different parts of the equipment have been connected, the PC should be switched on and the control software executed. Following this, it will be sufficient to follow the instructions as they appear on the PC screen. Consequently, **the UM2B unit should be turned on when this software so requires** (4).

THE UM2B UNIT SHOULD NOT BE TURNED ON UNTIL THIS IS INDICATED BY THE CONTROL SOFTWARE.

WARNING: If the equipment is used outside manufacturer's specifications, the security could be altered.

4.3.- Disconnection of equipment

ATTENTION!: The cabling should be handled with great care, since high voltage direct current is involved. There are moments during the test in which the equipment might be electrically charged at high voltage, and handling of the cabling or equipment after the test might be dangerous. Consequently, the habitual safety measures applied to high voltage installations should be taken into account.

Following performance of the test, the equipment itself will discharge the machine analyzed. Meanwhile, the computer will show a message indicating that this operation is being carried out. Consequently, **the UM2B unit should be turned off when so indicated by the control software, following the measurements.**

In some transformers, discharging may take several minutes. Consequently, it is good safety practice to use rubber gloves when handling the connecting clips.

When requested by the program, the UM2B unit should be disconnected in accordance with the following steps:

- Switch off the UM2B unit.
- Remove the clips from the equipment being tested.
- Remove the cables from the UM2B. If high voltage connectors are blocked, unblock them threading security screw that allows remove them.

5.- SOFTWARE DESCRIPTION

5.1.- Introduction

Along with other units and their respective applications (see Appendix B) the UM2B constitutes a system for the testing and analysis of electrical machines. Consequently, all these applications will be launched from a common base application known as the "*Electrical Machine Testing and Analysis System*" (Figure 5-1), which is located in the folder of the same name under **Start < Programs.**

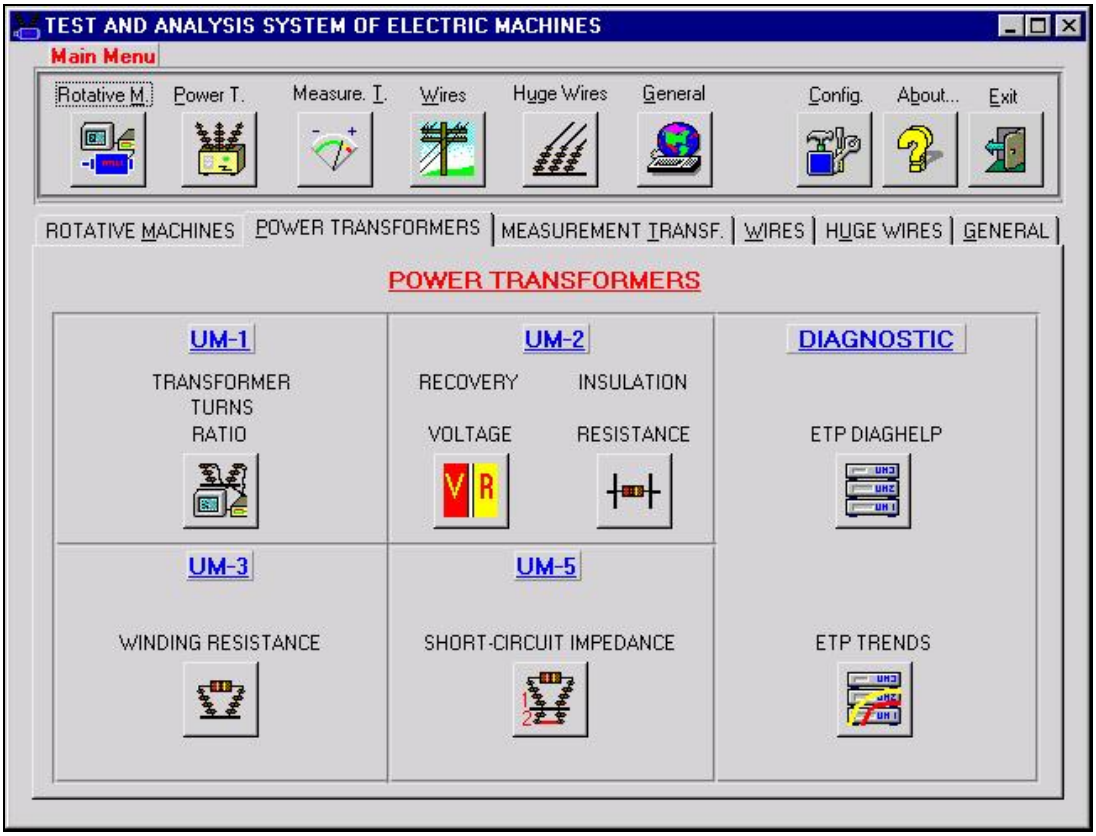


Figure 5-1: Test menu for power transformers.

This screen shows all the tests that may be performed on the different machines and / or components. If any of the options is shown disabled, it will be because the customer does not have the corresponding application, which he may acquire at any time (see chapter 8 and appendix B). The UM2B unit is delivered with the application "Recovery Voltage" and it's available another optional application "Insulation Resistance".

In this case, the tab entitled "POWER TRAFO" or "MEASURING TRAFO", or the corresponding icon at the top of the screen should be selected. Then click on the icon corresponding to the UM2B and the Recovery Voltage program will be launched (Figure 5-2) or the Insulation Resistance (ETPRA) if available. This last one will have the same menu to Figure 5-2 but without the icon's Recovery Voltage and Peak Time.

From this moment both applications: **Recovery Voltage** and **Insulation Resistance** will be described together because of their similarity, detailing when appear the differences or particularities that offer the Insulating Resistance software (ETPRA).

The main menu of the application offers basically two operating options:

- Test performance (**Test**).
- Analysis of results (**Analysis**).

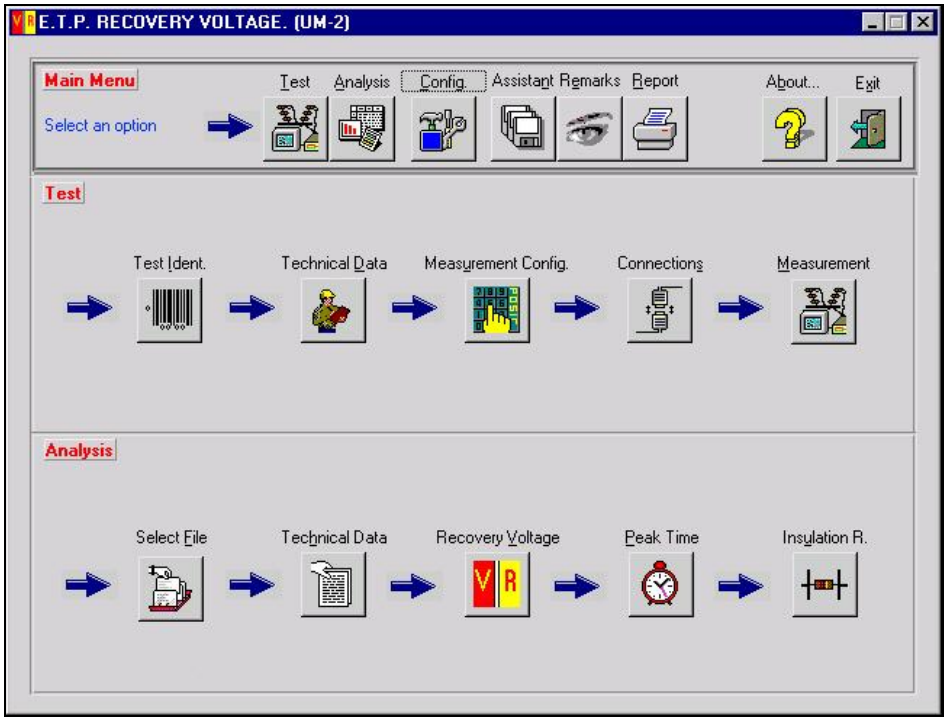


Figure 5-2: Main menu of the UM2B test recovery voltage.

For performance of the test a series of data identifying the machine is required, this being provided by the operator.

Subsequently, it will be possible to carry out an analysis of the results based on the voltages measured and the performance of a series of calculations.

Also provided is a series of utilities, such as a file copy assistant or a notepad for test or analysis events.

5.2.- Hardware dongle. Configuration menu

The first step to carry out before executing the application, is to place the security key (dongle) supplied in the parallel port of the PC (LPT1). In the case of not connecting it, the software will only allow you to carry out analysis of test already performed. When you connect it, you will be able to carry out a test.

For system configuration, click on **"Config"** button. Successively, the following menu will appear (Figure 5-3), in which one will choose the parameters of the system:

Figure 5-3: Configuration Screen.

- ***Control**:* the communication with the unit is performed by means of the serial port (RS-232). You will need to indicate which port will be used, (COM1- COM4), by means of the existent ring.

- ***Supply:*** First of all you will need to select the mains voltage, that will be 115 or 230 V. The frequency of mains voltage will also need to be selected, which will be 50 or 60 Hz, by means of the corresponding ring. The manipulation of this record is just informative, the user will have to check the proper supply of the unit from it's name plate.

- ***Language:*** Select one of the languages that are listed. Once selected, after finishing the program configuration, all the text of the application will change to the selected language.

- ***Date:*** The format of the date will be selected, be it day - month - year (DD-MM-AAAA), or month- day- year (MM-DD-AAAA).

- ***Temperature:*** Select the units used in the temperature; Fahrenheit (ºF) or centigrade (ºC).

- ***Topology:*** Select the nomenclature of the connection, be it, A – B - C or U – V - W.

Once the system is configured, press OK button to accept chosen configuration, or CANCEL, if you choose to refuse it.

5.3.- Test performance

Measurements performed using the UM2B system are accomplished OFF-LINE (out of service). Consequently, before beginning the test, THE EQUIPMENT UNDER TEST SHOULD BE GUARANTEED TO BE FREE FROM VOLTAGE.

Before beginning the test, the UM2B should already be connected to the PC by the series cable, BUT THE UNIT SHOULD NOT BE TURNED ON UNTIL REQUESTED BY THE SOFTWARE; no operation should be performed on the unit until the program checks that everything is correct prior to testing.

To perform good and reproductible results, its is recommended that the device under test had maintained all it's phases ground connected the longest possible time before the test. The minimun recommended length is of an hour or four times the length of the longest cycle of voltage insertion of a previous test. This way, the initial conditions are always the same and absorption capacitors (see figure 2.1) could be considered discharged. Also, if tests with another measuring equipment are going to be performed, it is therefore recommended that the first test should be the one with the UM2B unit.

It is necessary for the PC's screen saver to be deactivated and the low consumption mode disabled prior to beginning a test.

To perform a test, click on the **"Test"** button on the main menu. The system will be initialized, which may take several seconds. During this time, the message shown in Figure 5-4 will appear.

Figure 5-4: Starting message.

This button is used to initiate a new test, regardless of the stage of program execution. If a test was already being performed, the system will ask for confirmation of the intention to begin a new test (Figure 5-5).

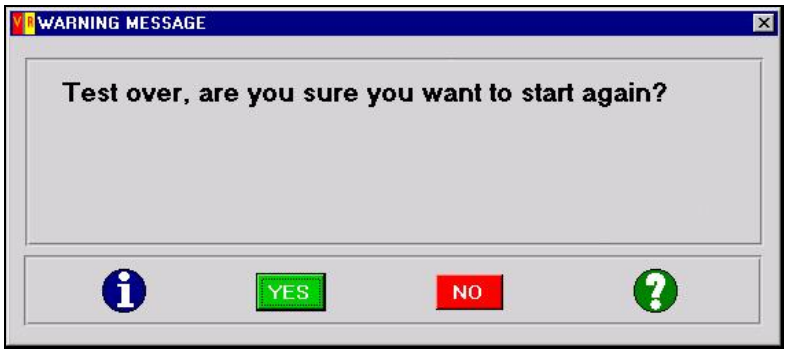


Figure 5-5: Warning of new test.

If the analysis of a previous test were being performed and this were interrupted, nothing will happen, unless any value that might affect the analysis had been modified, in which case a screen such as the one shown in Figure 5-6 will appear.

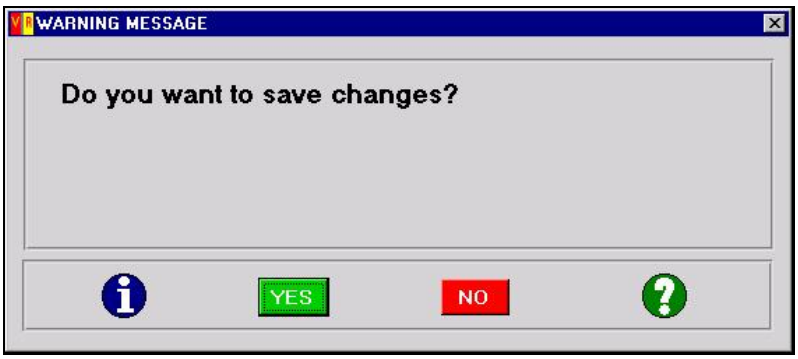


Figure 5-6: Warning to save changes.

It then checks for the existence of incomplete tests, which are considered to be those that have not been finished (e.g., interruption of power supply). The program offers the possibility of continuing with incomplete tests, eliminating all incomplete tests or beginning a new test (Figure 5-7).

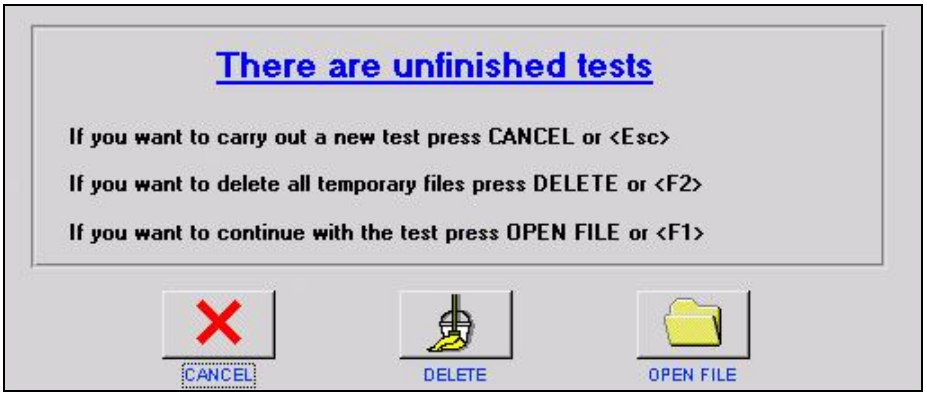

There are unfinished tests
If you want to carry out a new test press CANCEL or <Esc>
If you want to delete all temporary files press DELETE or <F2>
If you want to continue with the test press OPEN FILE or <F1>
CANCEL
DELETE
OPEN FILE

Figure 5-7: Warning of incomplete tests.

5.3.1.- Test identification

When the operator decides to perform a test, the first thing he should do is identify the transformer on which it is to be carried out, which will serve to give a name to the file containing the test data (Test identification). This identification is carried out on the basis of the following data, as shown in Figure 5-8:

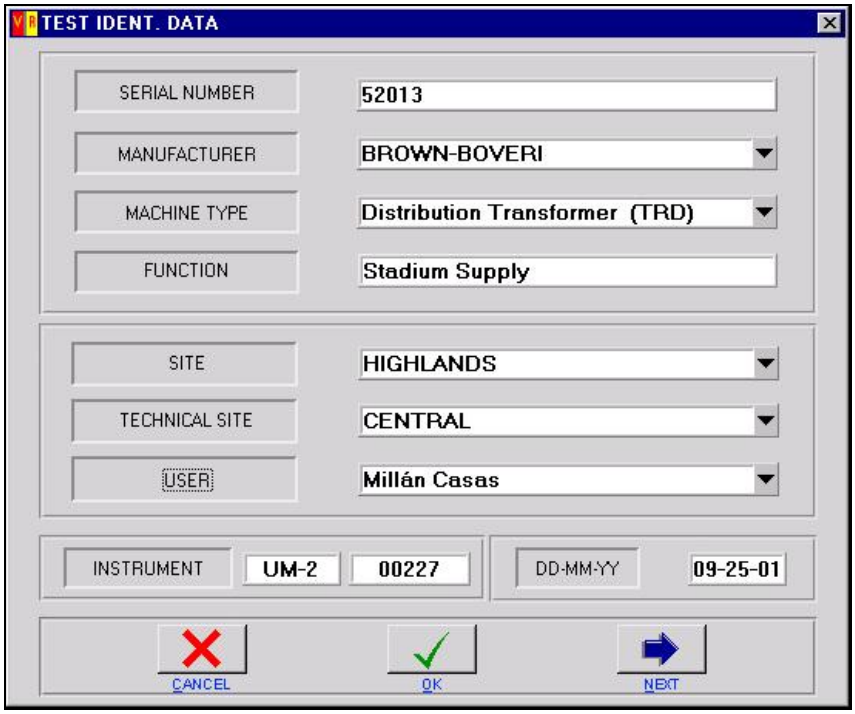


Figure 5-8: Test identification.

- **MANUFACTURING No:**
  Serial number of the transformer being tested.

- **MANUFACTURER:**
  The manufacturer is selected from a list. If the manufacturer in question does not appear, select **"other..."** to input the name of the new manufacturer (Figure 5-9). A similar window appears in all cases when the "**other…**" option is available.

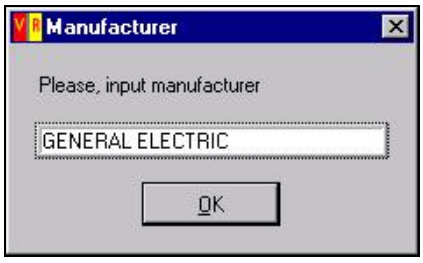


Figure 5-9: Enter manufacturer's name.

- **MACHINE TYPE:**
  The type of machine is selected from a list that cannot be modified by the operator.

- **FUNCTION:**
  The function of the transformer within the installation.

- **PLACE:**
  The name of the installation (e.g., Brighton thermal power plant) is selected from a list. If the facility in question does not appear, a new one may be input using the **"other..."** option.

- **TECHNICAL LOCATION:**
  The location of the machine within the facility (e.g., pump house) is selected from a list. If the location in question does not appear, a new one may be input using the **"other..."** option.

- **USER:**
  The name of the operator performing the test is selected from a list. If the operator in question does not appear, a new one may be input using the **"other..."** option.

- **INSTRUMENT (UM2B):**
  Serial number of the UM2B with which the test is performed.

- **DATE (DD-MM-YY):**
  Date of the test. The program checks that this date is correct.

In all those fields in which new items may be added to a list, it is also possible to delete them by locating the mouse cursor over the item in question and clicking with the right-hand button (Figure 5-10).

The introduction of all these data is obligatory; in other words, all the data should be correctly input for the program to allow the process to continue.

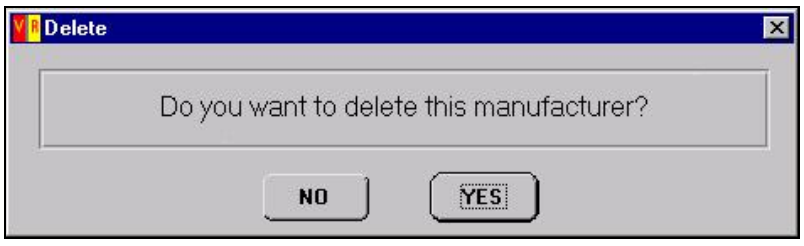


Figure 5-10: Warning for manufacturer's name elimination.

The **MANUFACTURING No, MANUFACTURER** and **MACHINE TYPE** fields are part of a *test search function*; in other words, if any test has been previously performed on the machine in question and any of these fields is filled in, the program will automatically fill in the rest (case of MANUFACTURING No) or limit the number of possible cases (see also section 5.4.1).

With the data input in the template, the program will generate a directory with the following structure:

C:\SAGEN_WIN\Ensayos\TTTFFFFFNNNN....

where:

TTT = Machine type.

Power transformer:	TRP
Distribution transformer:	TRD
Current transformer:	TRI
Voltage transformer:	TRV

FFFFF = Manufacturer's code.

The first five letters of the manufacturer's name. If this name has fewer than 5 letters, the rest will be filled in automatically with low hyphens, until the five characters are completed: " " | "_". If the name input contains any of the characters in brackets (**. / \ * ¿ : "**), these will be replaced automatically by the characters shown below, this occurring only when files are created in the PC, and not as regards what the operator sees:

.	|	¬	(Alt Gr + 6)
/	|	ß	(Alt + 225)
\	|	µ	(Alt + 230)
*	|	þ	(Alt + 231)
?	|	|	(Alt + 221)
:	|	¶	(Alt + 244)
"	|	§	(Alt +21)

NNN... = Manufacturing No

Identifier of transformer

For example, the tests performed on voltage transformer 123456 of the manufacturer "*Uniravis*" will be kept in the following sub-directory:

C:\SAGEN_WIN\Ensayos\TRVUNIRA123456

and those performed on power transformer 654321 belonging to the company "*ARK*" in the sub-directory:

C:\SAGEN_WIN\Ensayos\TRPARK__654321

There will be the same number of sub-directories in **C:\SAGEN_WIN\Ensayos** as there are machines that have been tested. In each sub-directory a series of files will be generated, which will have a nomenclature structure similar to that of the sub-directories. These files will have a 3-character extension (0 to 999), and will each contain a test on the same machine. The files that will be generated are as follows:

TDRTTTFFFFFNNNN⋯.nnn

This file will be used to record all the data on the complete test, in Excel format and text mode with tabulators.

medTDRTTTFFFFFNNNN⋯.nnn

This file is used exclusively by the program and contains all the test data. It cannot be edited by the operator.

TTTFFFFFNNNN⋯.cab

This file is used to record all the technical data on the transformer. It cannot be edited by the operator.

A temporary file will also be generated automatically in **C:\SAGEN_WIN\Ensayos** whenever a process is completed. This file, which is called **medTDRTTTFFFFFNNNN⋯.tnn**, serves as a back-up in the event of anomalous failure of the system, such that the program may continue at the last process performed. The file remains in effect only until the test is successfully performed, as from which moment the definitive file seen above is generated and this one is deleted.

The software of the UM2B uses this name-based structure to search for tests, as a result of which **THE USER SHOULD NOT ALTER THE NAMES GENERATED BY THE PROGRAM FOR EACH TEST.**

The identification window contains three buttons: (**OK**), (**CANCEL**) and (**NEXT**). The **CANCEL** button returns to the main screen without validating any possible change carried out in the window fields. The **OK** and **NEXT** buttons basically perform the same function, with the difference that the **OK** button validates the changes made in the window and returns to the main panel, while the **NEXT** button also validates the data but goes on to the next process to be performed. The functionality of these buttons will be the same in any window in which they might appear.

5.3.2.- Transformer technical data

This screen (Figure 5-11) is used to input the technical data on the transformer to be tested. The upper part of the screen shows the name of the file in which the test is to be stored, along with the data identifying the transformer and input from the previous screen. All of these appear on a yellow background, which indicates that they are purely for informative purposes, and cannot be modified.

- **TYPE:**
  Class of transformer used. This appears on the nameplate.

- **Transformer/Autotransformer:**
  This indicates whether the unit is a transformer or an autotransformer.

- **No Tertiary/Tertiary:**
  This indicates whether the transformer has or does not have a tertiary winding.

- **Single Phase/Three-phase:**
  This indicates whether the transformer is single phase or three-phase.

- **Y. OF MANUFACTURING:**
  Year in which the transformer was manufactured.

- **COOLING:**
  Type of transformer cooling. This may be by oil or dry.

- **POWER (MVA):**
  Maximum power of the transformer in millions of volt-amperes.

- **NOMINAL Vdc:**
  Nominal short-circuit voltage in percentage terms. This is the percentage of the rated voltage that needs to be applied to the *high voltage* winding for the nominal current to circulate through the *low voltage* winding when the latter is shorted. This is shown on the nameplate.

- **CONNECTION GROUP:**
  This is the winding connection group for three-phase transformers. By clicking on the indicator a list of the existing possibilities is shown. For groups in which ‘N/n’ appears, one of the windings has an accessible neutral:

if the indication is '**N**' (e.g.: YNy0) the high voltage winding has the accessible neutral, and if '**n**' (e.g.: Dyn5) it is the low voltage winding.

- **TERTIARY GROUP:**

  This indicates whether the transformer has a third winding, in addition to the high and low voltage windings.

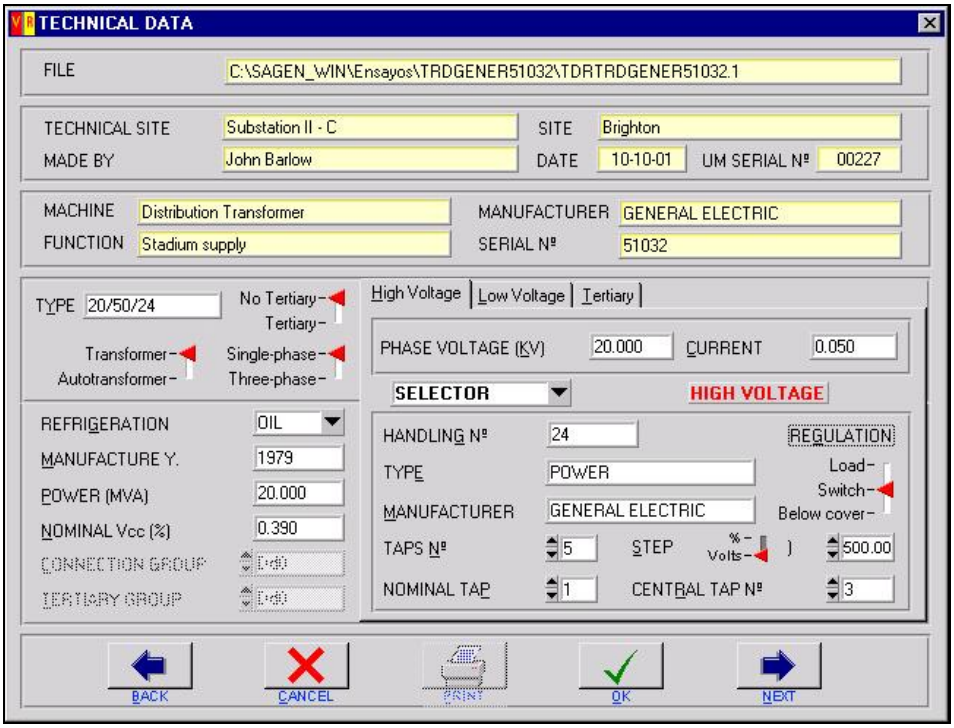


Figure 5-11: Enter the technical data of the transformer.

Other parameters for each of the windings may be selected on the right, such as the following:

- **COMPOUND VOLTAGE (KV):**

  Nominal voltage between two phases of the winding. In the case of delta connections, this matches with the simple or phase voltage. For more information, refer to Figure 5-12.

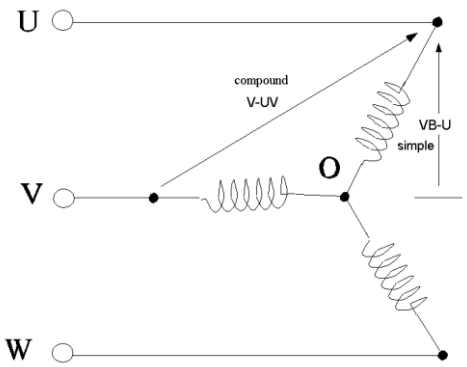


Figure 5-12: Diagram of simple/compound voltage.

- **CURRENT (A):**
  Nominal current of the winding.

There is also a list-type selection box which indicates whether the winding has a regulator, and adjuster or neither. If the winding has a regulator/adjuster, there will be an additional series of parameters:

- **TYPE:**
  Model of regulator/adjuster. This is defined on the nameplate.

- **MANUFACTURER:**
  Name of regulator/adjuster manufacturer.

- **N. OF OPERATIONS:**
  Number of times that the position of the transformer regulator has been modified in operation (modifications undergone during test performance do not count).

- **REGULATION:**
  Type of regulator. May be under load, a switching regulator or under cover.

- **No OF POSITIONS:**
  Number of regulations positions of the regulator/adjuster.

- **STEP:**
  Increase in magnitude between one position and the next. This may be defined in volts or in percentage terms (%), with respect to the rated voltage. If define in percentage terms (%), the increase may not exceed 100; if this occurs, an error message appears (Figure 5-13).

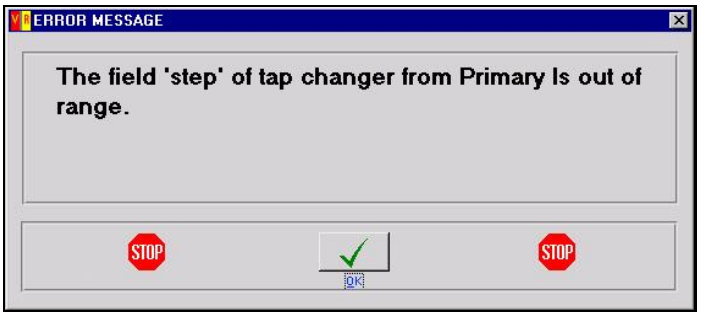


Figure 5-13: Warning for limit of step voltage.

- **NOMINAL POSITION:**

  Regulator/adjuster tap, to which the nominal magnitudes of the transformer (voltage, current, etc.) refer.

- **No OF CENTRAL POSITIONS:**

  Number of positions for the nominal position (maximum of 6). Normally there will be one only. If there is more than one, the nomenclature will consist of the central position plus a letter indicating the number of the central position. For example: 12a, 12b, …

5.3.3.- Configuration of measurement

Recovery Voltage Software

This screen (Figure 5-14-a) is used to select the voltage at which the test is to be performed and the initial cycle time during which this voltage is to be applied (time base), along with the transformer connection mode (if the measurement is performed between high and low voltage or between high and tertiary) and the temperature of the transformer. Depending on the time base selected, there will be a larger or smaller number of measurement cycles (the longer the time, the smaller the number of cycles). Also indicates, in function of cycles number and time base, minimum test duration and maximum load time.

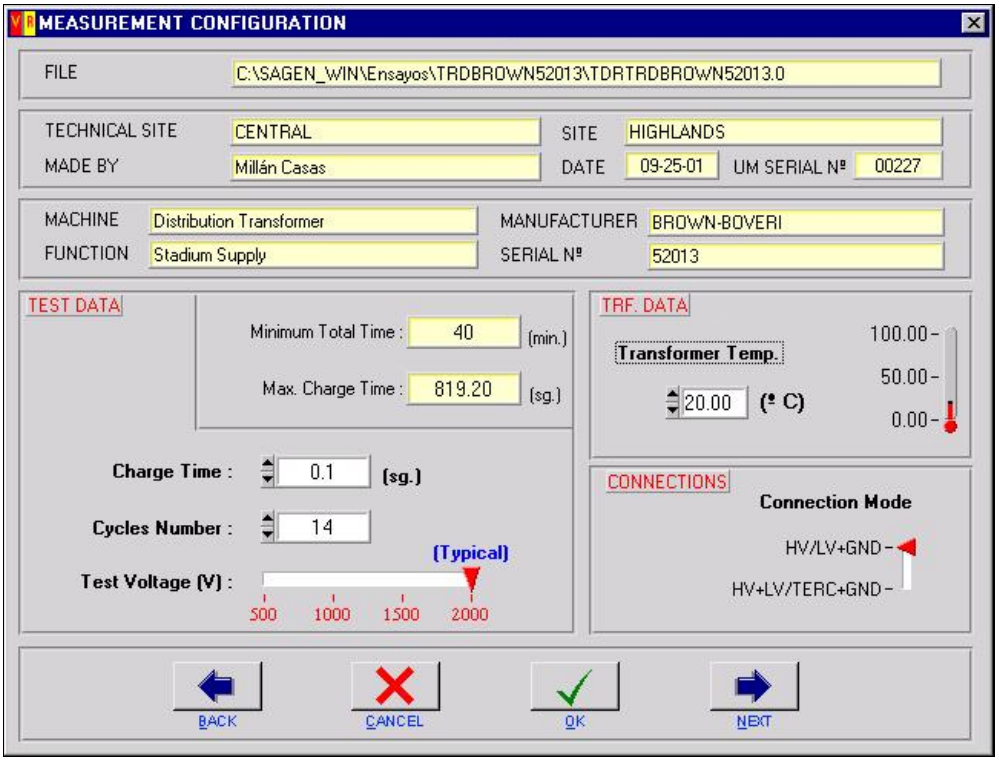


Figure 5-14-a: Menu for test configuration (Recovery Voltage).

Insulation Resistance Software (ETPRA)

In this screen (Figure 5-14-b) are selected the voltage for the test, the time that is going to last , the connection mode of the transformer and his temperature.

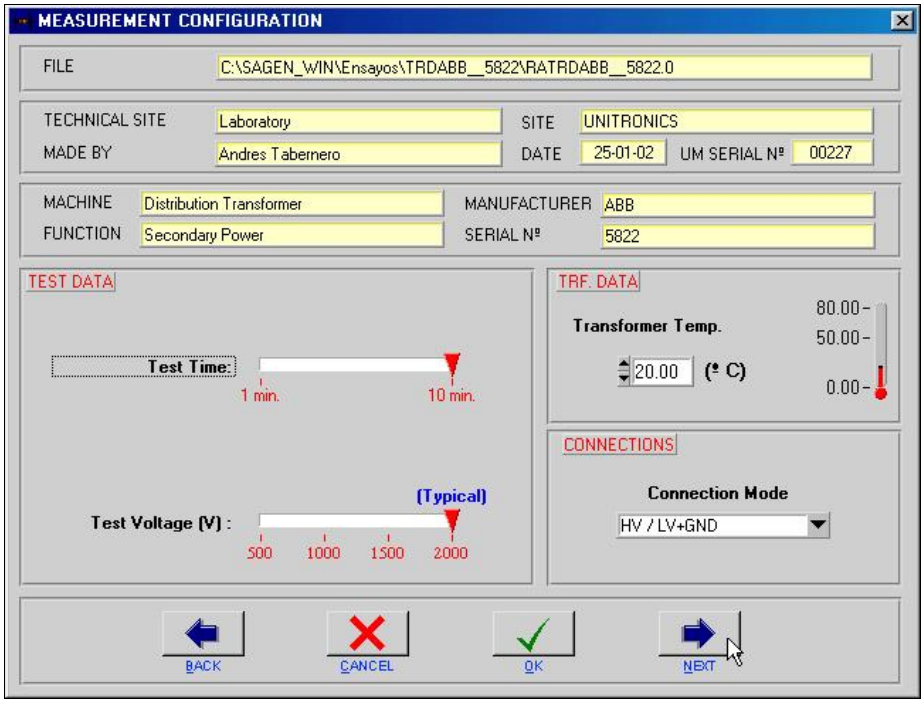


Figure 5-14-b: Menu for test configuration (Insulation Resistance).

5.3.4.- Connection

This window indicates the correct connection of the equipment with the transformer on which the test is to be performed. Before taking any action, **check that the equipment to be tested is free from voltage. If the transformer had been phase – grounded to eliminate charges the short-circuit should be eliminated.**

The program checks that the UM2B is turned on and that the serial cable between the computer and the UM2B is correctly connected. A screen appears with instructions on how to proceed as regards connection of the unit (Figure 5-15). Any errors in this *connection protocol* are indicated by means of luminous signals: if the LED located to the left of the text flashes, it means that the condition is not met. Likewise, **the equipment should be connected to a grounded supply socket**, since otherwise the equipment may be damaged or the measurements taken may be incorrect.

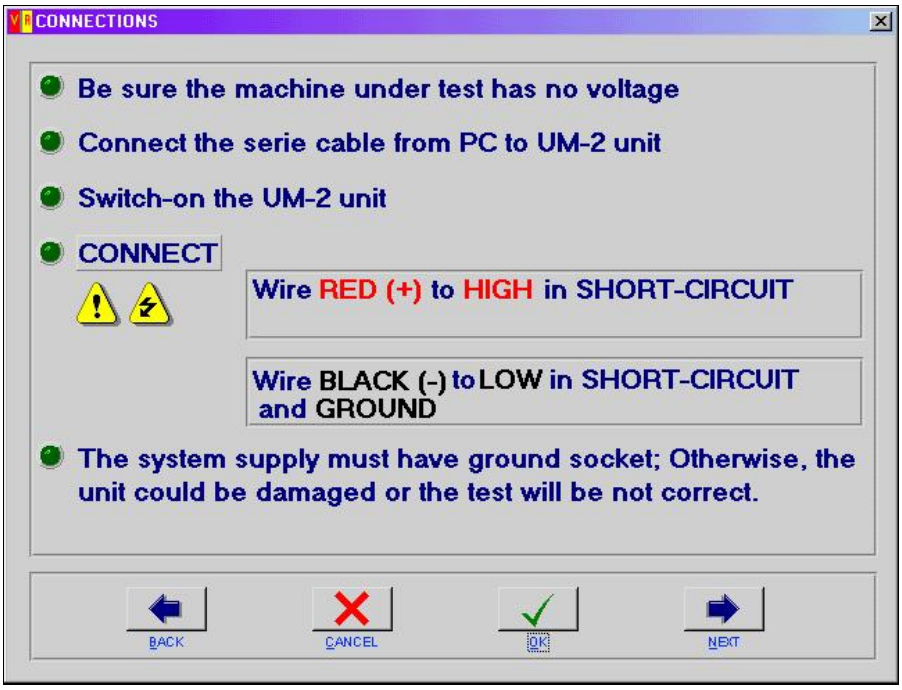

CONNECTIONS
Be sure the machine under test has no voltage
Connect the serie cable from PC to UM-2 unit
Switch-on the UM-2 unit
CONNECT
Wire RED (+) to HIGH in SHORT-CIRCUIT
Wire BLACK (-) to LOW in SHORT-CIRCUIT and GROUND
The system supply must have ground socket; Otherwise, the unit could be damaged or the test will be not correct.
BACK
CANCEL
OK
NEXT

Figure 5-15: Menu for unit connection and wiring to the transformer.

When UM2B unit is powered on, the connection will be established between this and the PC. This may take a few seconds, during which time the program will indicate that it is attempting to connect to the UM2B unit (Figure 5-16).

Figure 5-16: Message indicating the PC is attempting to establish communications with the unit.

ATTENTION: For correct operation of the equipment, it is very important that all the conditions listed in this window are met.

Once all the conditions are met, the **OK** and **NEXT** buttons will be enabled.

5.3.5.- Measurements

Recovery Voltage Software

The measurement of both the recovery voltage and the insulation resistance are performed in this section. The upper part of the measurement screen (Figure 5-17) includes a graphic that will show the recovery voltage throughout the test. The lower left-hand part of the screen shows information on the insulation resistance at two moments in time (minutes 1 and 10), as well as the polarization index and time constant when them can be computed. To the right is the recovery voltage at each moment of the measurement and indicators showing the number of cycles remaining to be performed, the time that has elapsed since initiation of the test and the time remaining for completion of the current cycle.

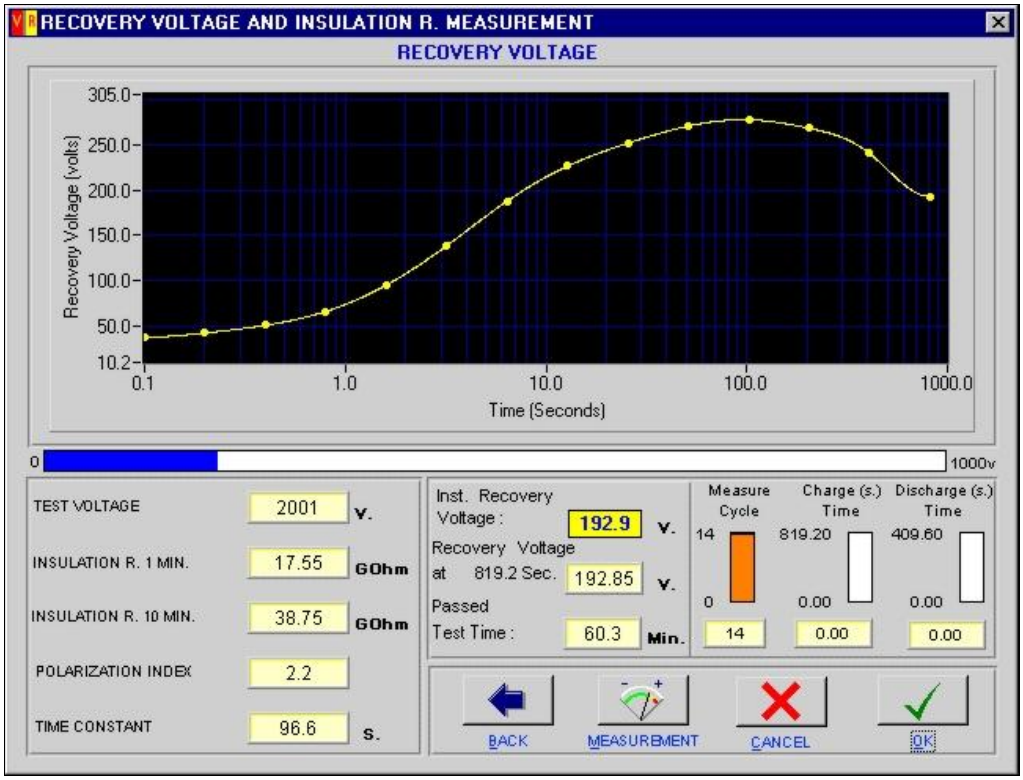


Figure 5-17: Screen for test evolution (Recovery Voltage).

The number of cycles that the test will last depends on the time base selected in configuration of the measurement; if this is large, the number of cycles will be smaller. If the charge time in one of the cycles is greater than 10 min, the software takes advantage to measure insulation resistance (Figure 5-19-a). If it was not measured at the end of the test, the software will ask the user if he wishes to do it (Figure 5-18). It will also be asked for if the user cancels the test and the resistance was not measured.

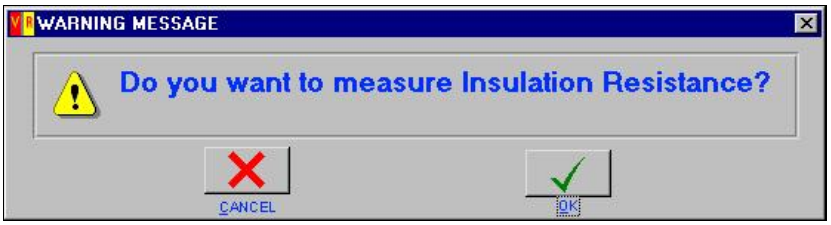


Figure 5-18: Warning message.

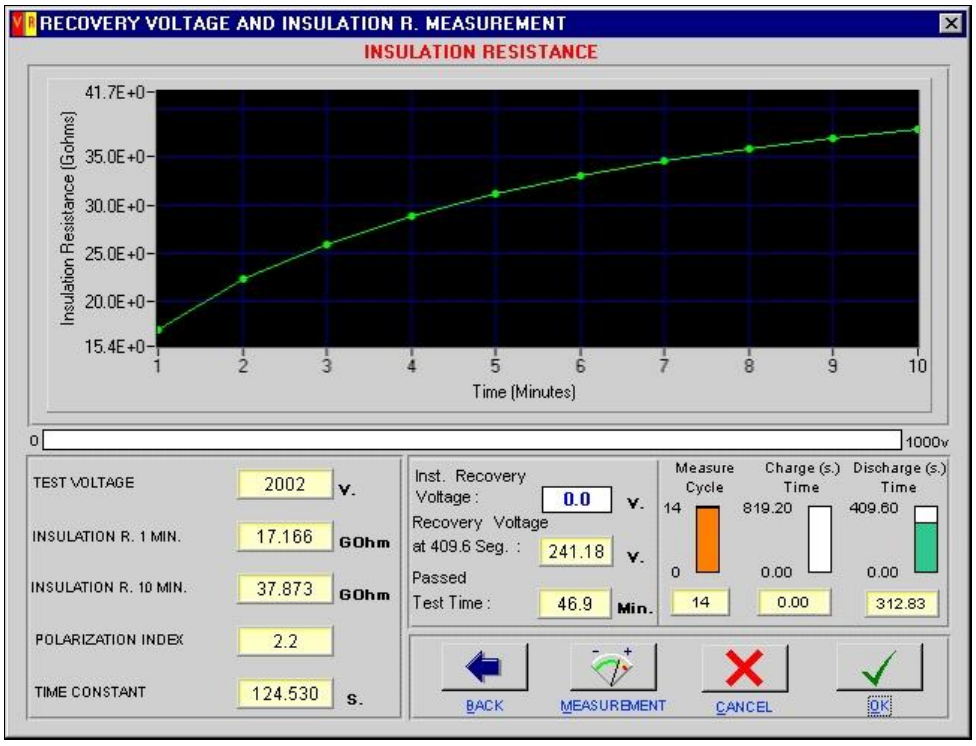


Figure 5-19-a: Measurement Screen (Recovery Voltage).

Insulation Resistance Software (ETPRA)

In this screen is performed the measurement of insulation resistance. The upper part of the measurement screen (Figure 5-19-b) includes a graphic that will show the evolution of the insulation resistance throughout the test. The lower left-hand part of the screen shows information on the insulation resistance at two moments in time (minutes 1 and 10), as well as the polarization index and test voltage. To the right are two indicators: one indicates the complete elapsed time (including the machine's discharge time) and the other the time it will take to measure the insulation resistance. This last one will pause at the moment in which the unit is performing the measurement. When arriving zero, the test will be over.

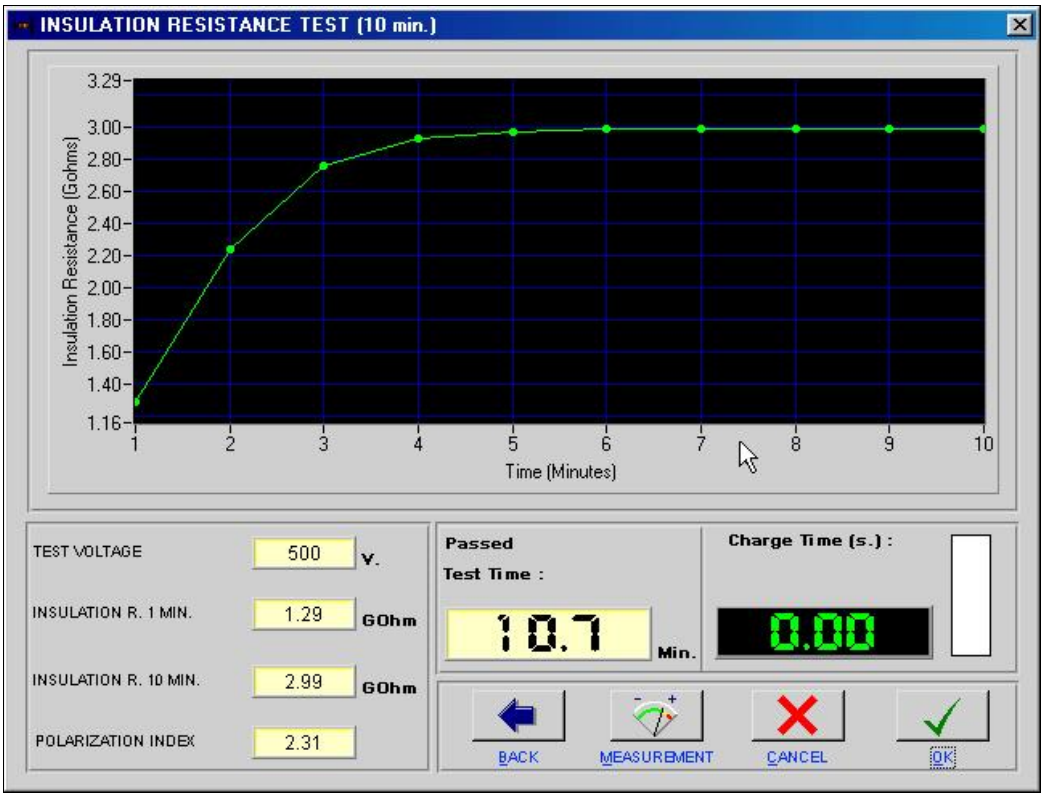


Figure 5-19-b: Measurement Screen (Insulation Resistance).

To initiate measurement, click on the button, and, in case the high or low voltage of the machine (in function in the connection mode) is inferior than the test voltage selected by the user, the following warning message will be shown (Figure 5-20):

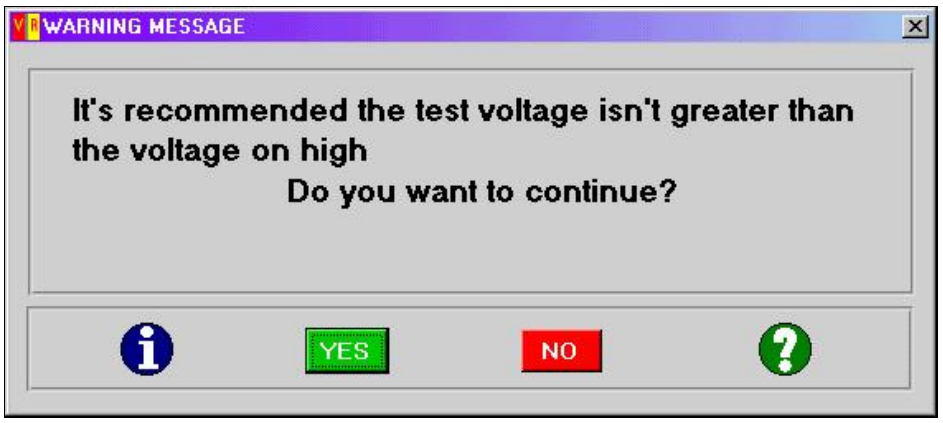


Figure 5-20: Warning message.

Subsequently, the program will undertake calibration of the UM2B, showing the message that appears in Figure 5-21 throughout the process. The indicator bar shows the time last in seconds.

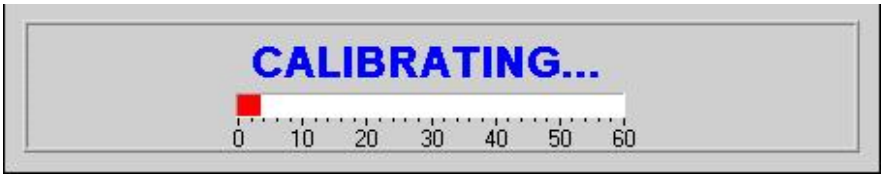


Figure 5-21: Calibration message.

In case the machine is not completely discharged, the unit will detect it, and it will warn the user with the following message, giving option to discharge it (Figure 5-22). If this discharge is not performed, the graph of recovery voltage could result altered from the one that should be drawn, most of all appearing a higher voltage in the first cycles.

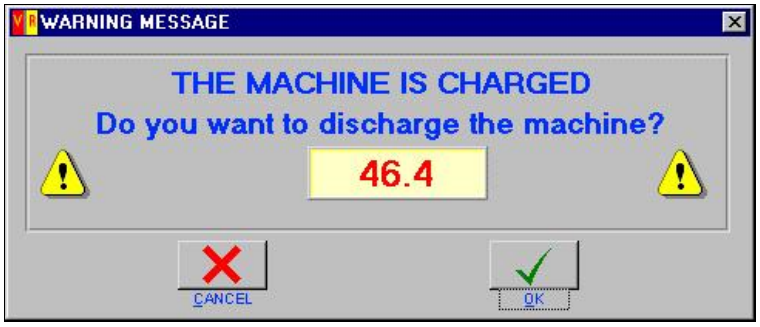


Figure 5-22: Warning message. The machine is charged.

In the measure process, a short circuit could appear in any instant (accidental union of the measure clamps). The unit is able to detect short circuits when load time overcomes 2 seconds. In this case, it will show the following informative message, in which indicates that the connections should be revised (Figure 5-23). Once revised, it will be necessary to repeat the test:

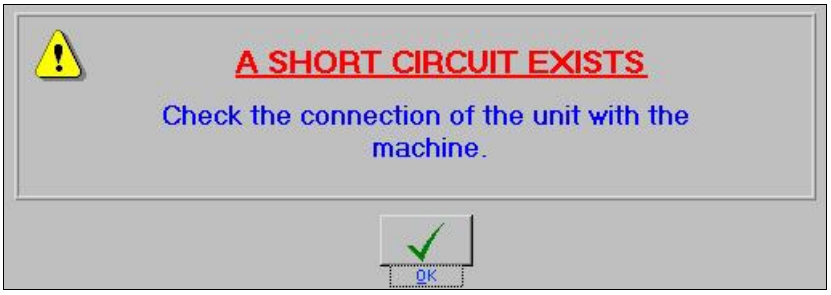


Figure 5-23: Short circuit message.

In the case of not existing short circuit, voltage will be applied to the transformer for the period established (Figure 2-2, phase 1) in the time base on the previous screen; the machine will then be short-circuited and the recovery voltage measured (Figure 5-24).

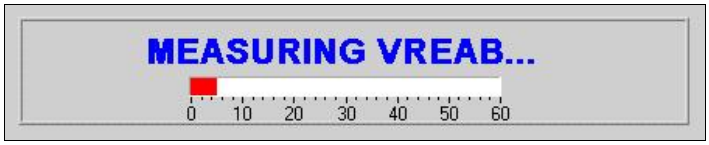


Figure 5-24: Message for search of maximum recovery voltage in current cycle.

On completion of the measurement, the maximum result will be shown in the corresponding box and will be plotted on the graph. The transformer will then be discharged, the message shown in Figure 5-25 appearing throughout the entire process.

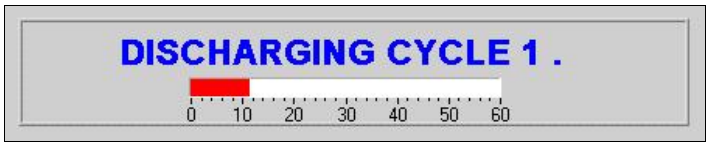


Figure 5-25: Discharge message.

Once the measurement has been completed (all the cycles are finished), the program will undertake the complete discharge of the transformer; during this time, the message shown in Figure 5-26 will be displayed.

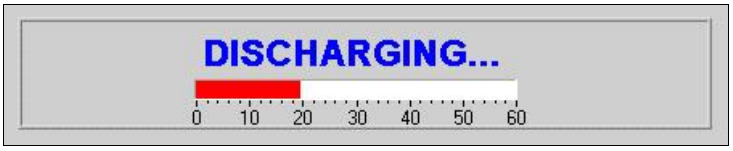


Figure 5-26: Final discharge of the transformer.

If there is no problem, the program will show Figure 5-27 on completion of measurement for all the cycles, indicating that the test has been completed. The unit will indicate the end of the test to the user by means of a series of acoustic sounds to claim his attention. This is specially useful if the user is far from the unit performing another work while the test evolves.

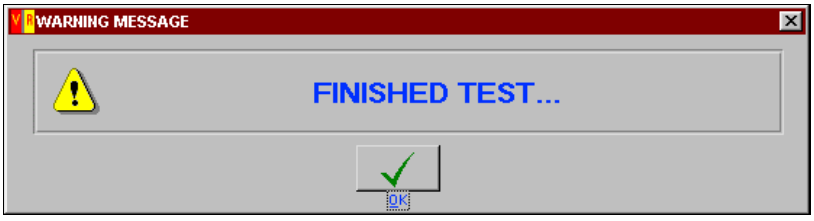


Figure 5-27: Warning for test end.

The measurement may be cancelled at any moment by clicking on the button. If this occurs, the program will undertake discharging of the transformer (Figure 5-26), and will remain ready for a new measurement.

5.4.- Test analysis

The analysis of a test is made up of a series of screens that show the technical data on the transformer and graphics and tables with the results obtained. The Recovery Voltage application screen is the one in figure 5-28 and the one of the Insulation Resistance application would be she same but without the icons: Recovery Voltage and Peak Time.

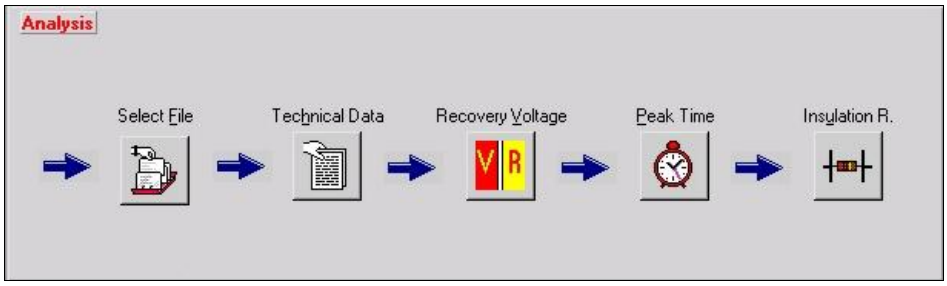


Figure 5-28: Process of analysis of the test results.

To perform an analysis, click on the "**Analysis**" button on the main menu. This button is used to begin a new analysis, regardless of the degree of execution of the program. If a test was being performed previously, the system will ask for confirmation of the step (Figure 5-29).

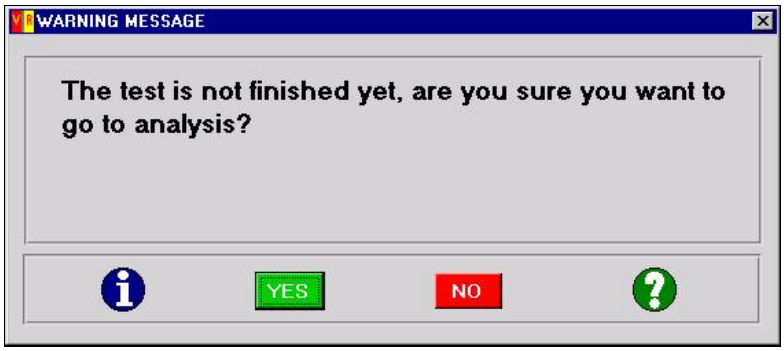


Figure 5-29: Confirmation of change to analysis.

If the analysis of a previous test were already under way, then nothing will happen if this is interrupted, unless a value had been modified. In this case, Figure 5-30 would be shown.

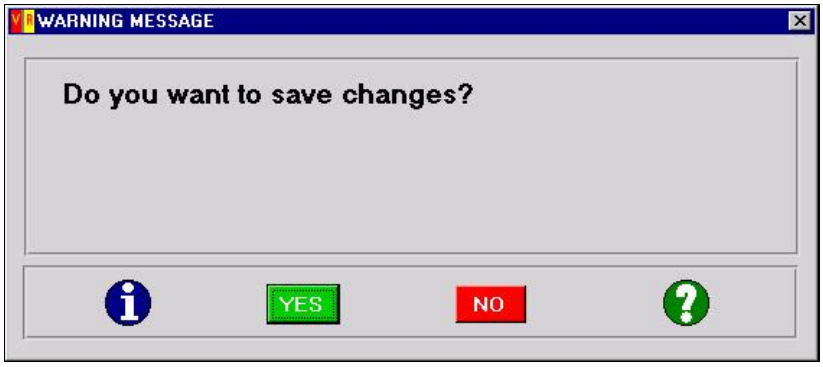


Figure 5-30: Warning for data update.

5.4.1.- Select test file

By clicking on this button, and as long as there are tests in the directory \SAGEN_WIN\Ensayos\, the test search function shown in Figure 5-31 will appear.

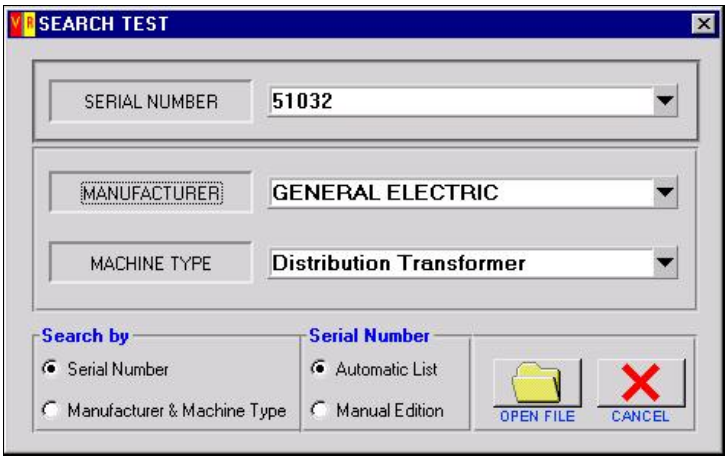


Figure 5-31: Test search.

If the search is performed by **manufacturing No,** it may be performed manually or automatically. If automatic, a menu will appear when this control is clicked on, showing the serial numbers of the machines tested, and the rest of the fields will be filled in automatically. If the search is performed manually, the serial number has to be input. If any test on this transformer is found, the rest of the fields will be filled in; otherwise, they will be left blank, indicating that there is no test on this machine.

If the search is performed by **manufacturer** and **machine type,** it will be highlighted in a gray box in this zone, and when one of these fields is clicked on. A menu will appear with the manufacturers or types of machines. If when one of these is selected the field is not

filled in automatically, it will be because no test has been performed on a machine having the selected characteristics. If the field is filled in, there may be various transformers with these characteristics, and the one desired should be selected by clicking on the tab of the manufacturing number.

Once the machine to be analyzed has been selected, click on the button and the file selector will appear (Figure 5-32); this may be used to select the test to be analyzed for this machine.

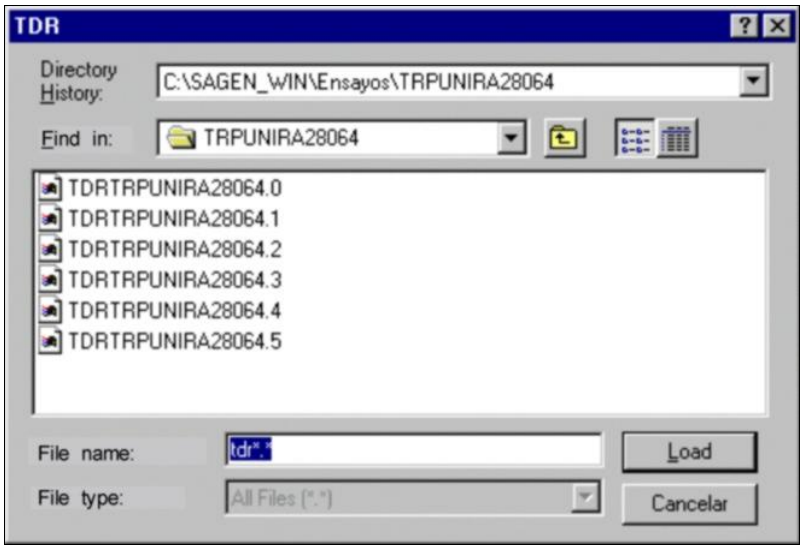


Figure 5-32: Selector of files to analyze.

Following the selection of the test, this is loaded into the memory by clicking twice on the test itself or on the "**Load**" button. Prior to doing this, the program checks that it is actually a UM2B test file; if this is the case, it is loaded in the memory; otherwise, the program informs that it is an incorrect file (Figure -33) and offers the possibility of choosing another (Figure 5-32).

Figure 5-33: Warning for incorrect file.

5.4.2.- Transformer technical data

Once a test has been loaded, the program displays a screen (Figure 5-34) which shows the data identifying the test in its upper part and technical data on the machine in the lower. For more information on the meaning of these data, refer to section 5.3.2. Although these data are merely informative, the operator may change them, with the exception of the data identifying the test. This is indicated by the background of the indicators: if the background is yellow, the field cannot be modified; if it is white, the data may be changed. This is valid for the entire analysis.

The name of the file subject to analysis is shown all the time in the upper part of the screen.

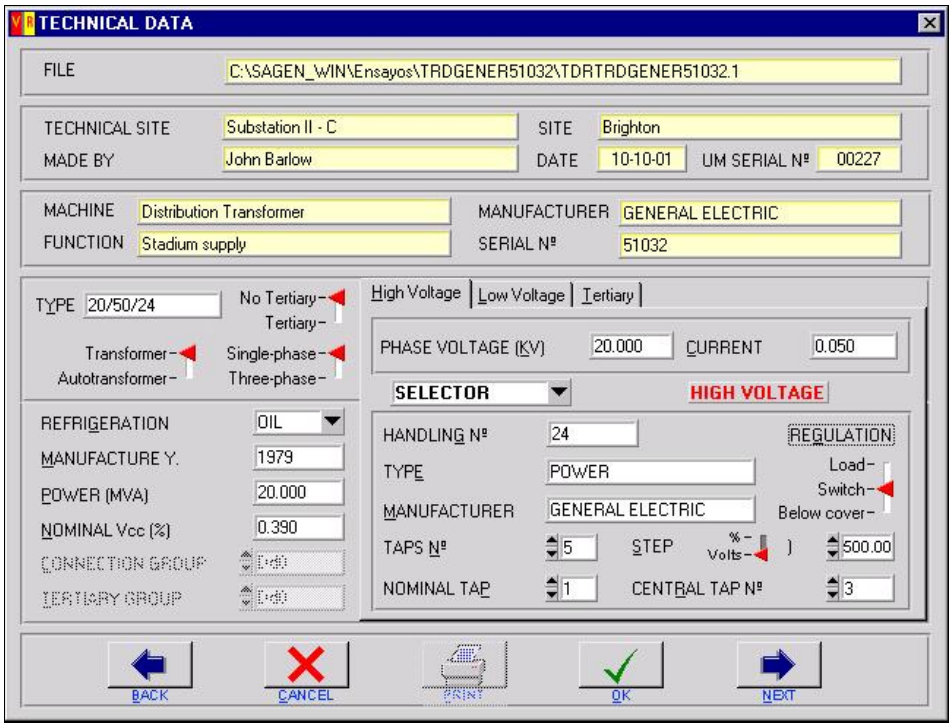


Figure 5-34: Analysis screen, technical data.

On all screens in which the button appears, there is the possibility of printing the current screen or the complete test report (Figure 5-35). For more information on reports printing, refer to section 5.7.

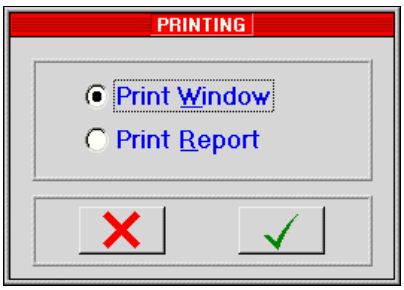


Figure 5-35: Printing options.

If any of the data influencing the calculation of the resistances are modified, when moving to another screen, the program will show a warning reminding the operator that data have been modified and that this may affect certain measurements (Figure 5-36).

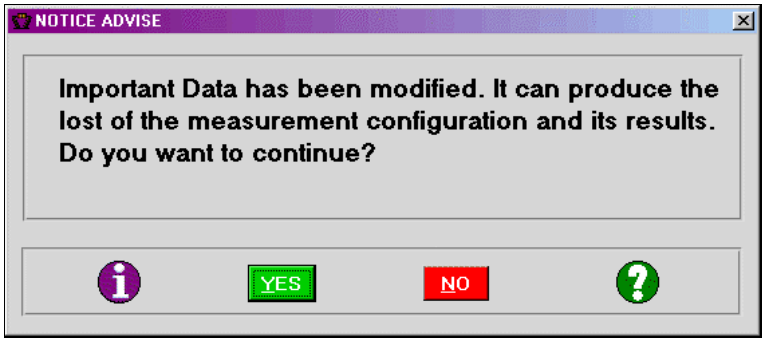

NOTICE ADVISE
Important Data has been modified. It can produce the lost of the measurement configuration and its results. Do you want to continue?
YES
NO

Figure 5-36: Warning of data changes.

The normal thing will be not to continue, as a result of which when the "NO" button is pressed, a screen will appear stating that the **CANCEL** button should be pressed if the change is not to take effect (Figure 5-37).

Figure 5-37: Warning screen.

5.4.3.- Recovery voltage

This screen shows the maximum dots of recovery voltage measured at the different cycles during the test. As in all the analysis screens (recovery voltage, peak time and insulation resistance), the upper part shows the name of the file being analyzed and certain data, such as the time base selected for the test, the transformer temperature, the type of cooling, type of connection and the voltage at which the test is performed, along with other data such as the time constant and polarization index.

Below these informative data there is a graphic showing the evolution of the recovery voltage throughout the test (see: Figure 5-38). To the right of this graphic there are two columns showing the times at which each recovery voltage sample has been taken and the corresponding value.

The operator may move through this graphic using the cursors and/or the mouse. As the cursor is moved, the value of recovery voltage and corresponding time are shown below, in the right-hand corner.

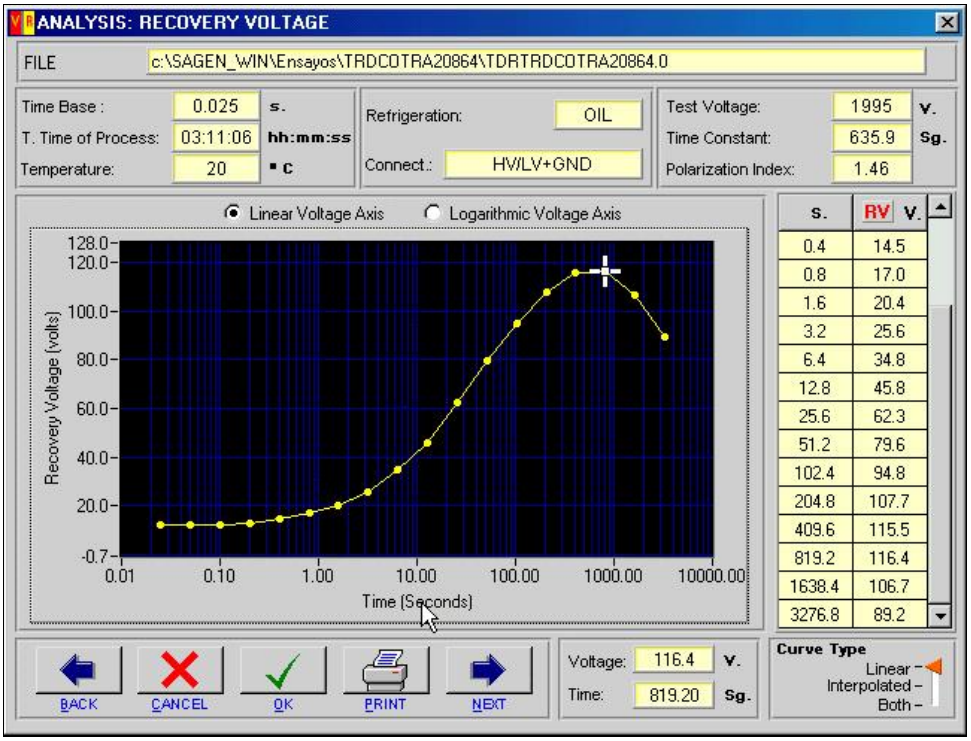


Figure 5-38: Analysis screen: Recovery diagram. Lineal graph.

Below the table of values of the graphic there is a selector which may be used to select the type of curve to be used to display the recovery voltage. Three display modes may be chosen: Linear curve (Figure 5-38), on which each point sampled is connected to the adjacent points by a straight line; Interpolated curve (Figure 5-39), where the points are connected by curves; and Both (Figure 5-40), with the linear and interpolated curves displayed on the same graphic.

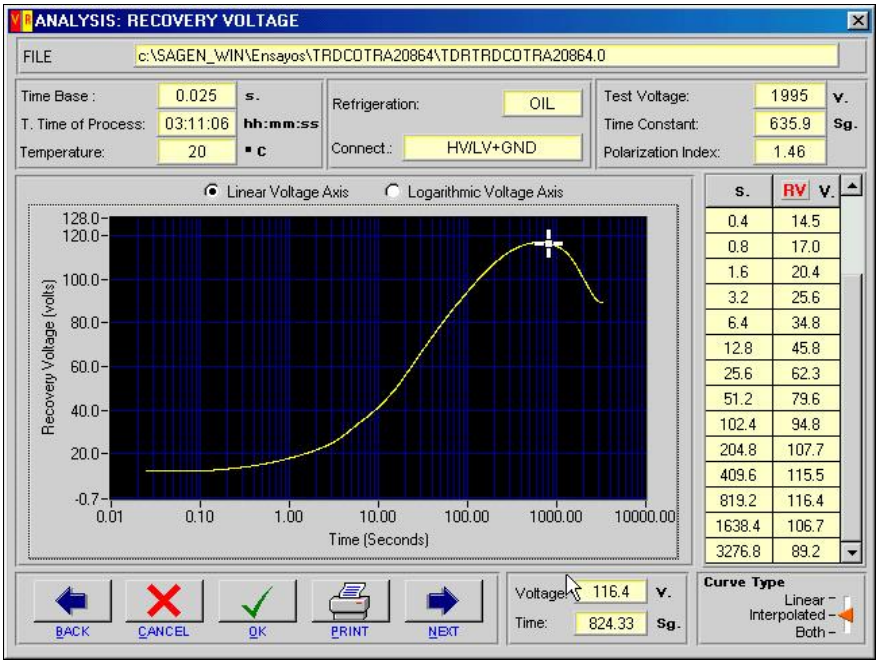


Figure 5-39: Recovery graph: Interpolated plot.

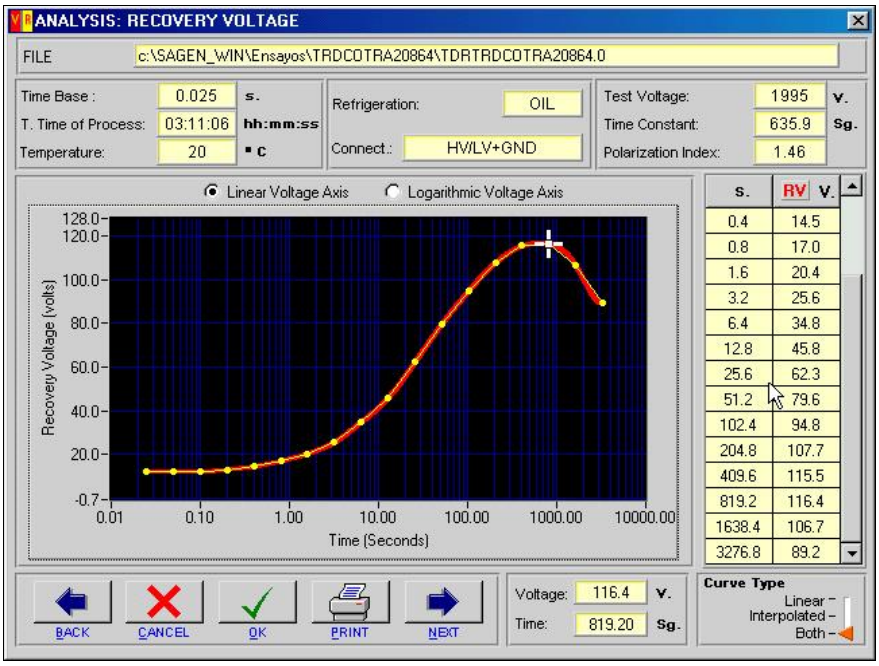


Figure 5-40: Recovery graph: both plot.

5.4.4.- Peak time

This screen is very similar to the previous one , but instead of showing the recovery voltage, it is shown the time (a dot) it takes to the dielectric to arrive to each cycle's maximum recovery voltage sample. In this case the operator cannot move around the graphic, but – as in the previous case – the rise time to the recovery maximum at different cycles of the test is shown to the right.

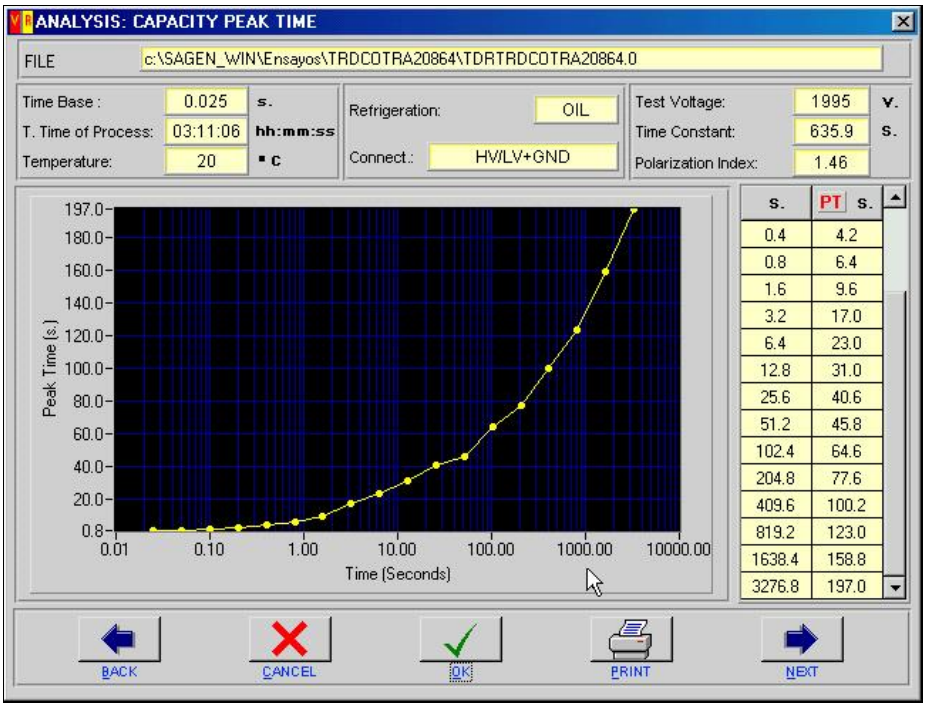


Figure 5-41: Analysis: Recovery peak time.

5.4.5.- Insulation resistance

Recovery Voltage Software

This screen (figure 5-42-a) shows the insulation resistance evolution referred to 20ºC. Consequently, if the temperature of the transformer is different, the program will carry out a conversion to offer it at 20ºC. The measurement of insulation resistance is independent from the rest of the measurements (the selected time base is not taken into account) and is performed in a cycle of more than 10 min, or at the end of the test, with a sample taken every minute.

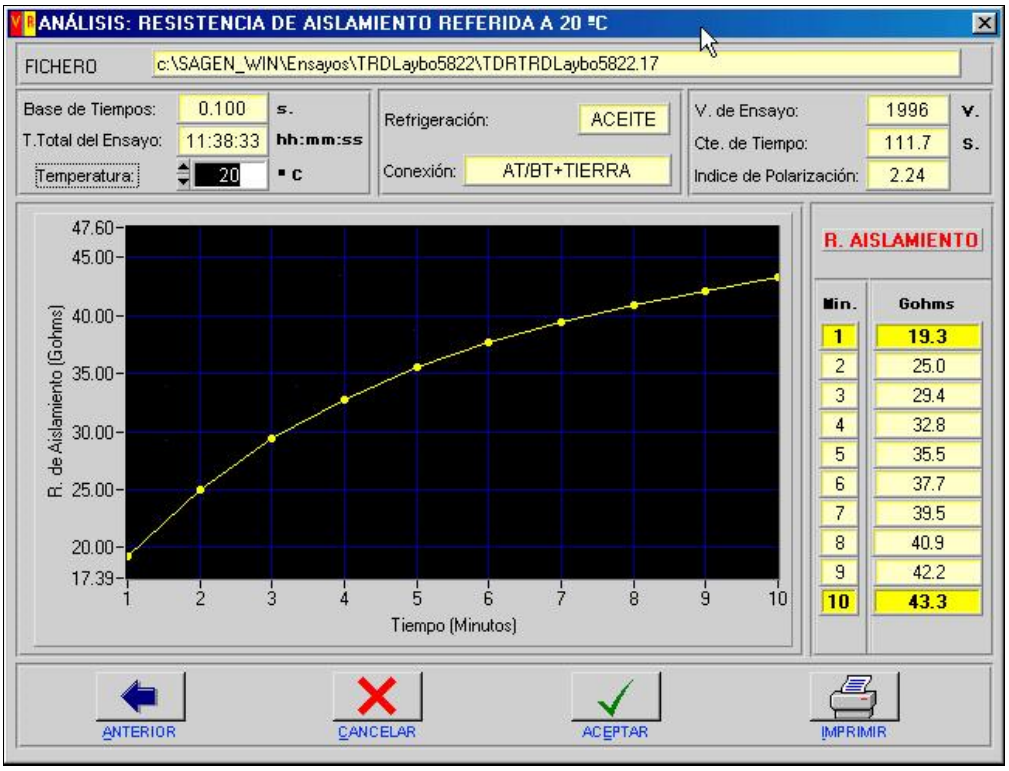


Figure 5-42-a: Analysis: Graph of insulation resistance (Recovery Voltage SW).

Insulation Resistance Software (ETPRA)

This screen (figure 5-42-b) shows the insulation resistance evolution referred to 20ºC. taking into account the temperature of the transformer. The field "Temperature" should have the value entered in "Test configuration" section while in Test phase. This field can be edited to let the user:

- Compensate to another temperature as the user forgot entering the temperature of the test or did not know that moment the test temperature. So entering the temperature all the measurements would appear compensated to that value.

- Take to the screen the real measurement taken by the unit. If the user wishes the measurement without any compensation, just have to enter the value 20 (20ºC). This way will get the actual uncompensated temperature.

Insulation Resistance measurement is performed taking one sample each minute in 10 minutes tests and each ten seconds in 1minute last tests.

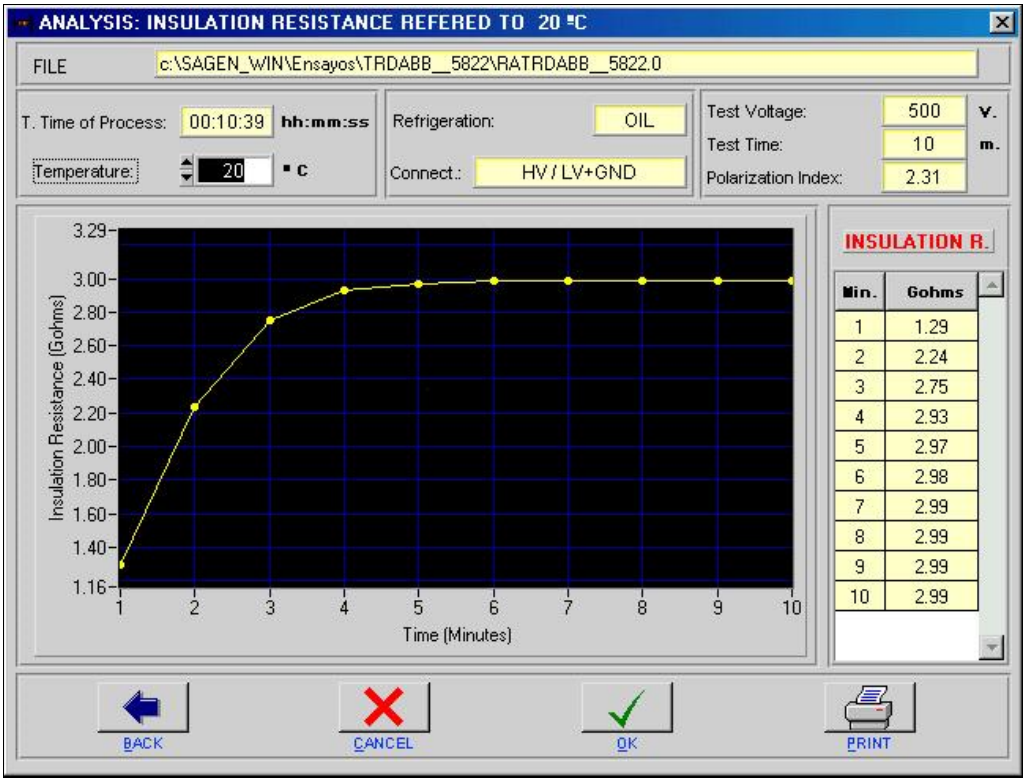


Figure 5-42-b: Analysis: Graph of insulation resistance (Insulation Resistance SW).

5.5.- Test duplication assistant

Given the number of files involved in the test, and in order to facilitate the work of the operator as regards their storage, the program incorporates a utility that allows tests to be copied to a location different from that originally used by the program, with the possibility for both the point of origin and the destination to be fixed, flexible or network units. When the is pressed, Figure 5-43 will appear.

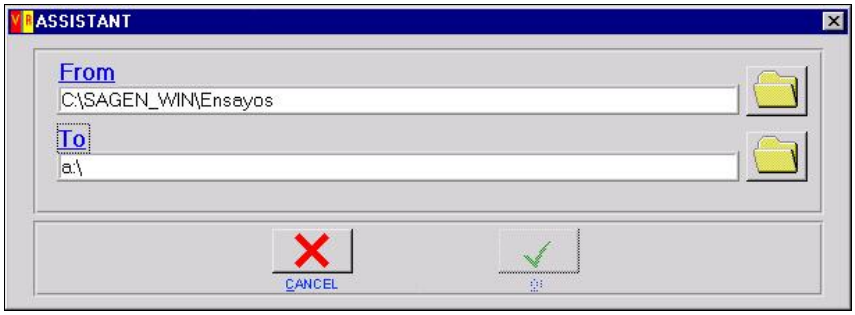


Figure 5-43: Assistant for test duplication.

In "**Origin**" the name of the test file to be recorded is selected, and in "**Destination**" the directory in which the test is to be recorded.

5.6.- Remarks page

The program also incorporates a utility known as "**Remarks**", where the operator may take notes and/or record events occurring during the test, with a maximum of 25 lines and 80 characters per line. The button will be activated whenever a test or analysis is being performed.

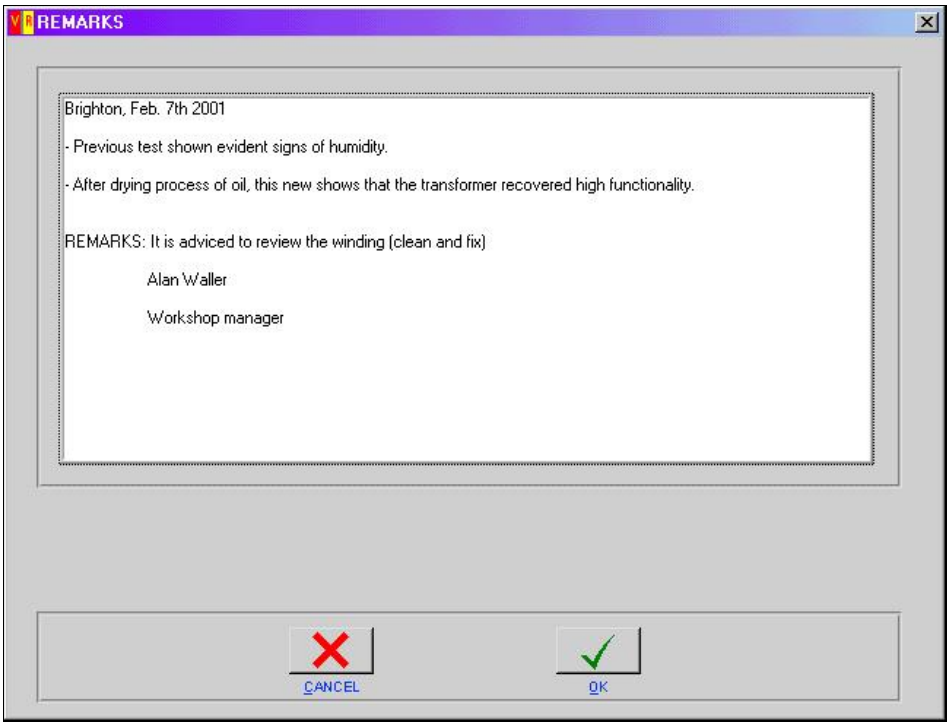

REMARKS
Brighton, Feb. 7th 2001
- Previous test shown evident signs of humidity.
- After drying process of oil, this new shows that the transformer recovered high functionality.
REMARKS: It is adviced to review the winding (clean and fix)
Alan Waller
Workshop manager
CANCEL
OK

Figure 5-44: Remark editing page.

The information is stored in the test itself, as a result of which it is not accessible from any editor, but only from the program. When the analysis of a machine is selected and a previous test or analysis has already written an observation, this observation will appear when the "**Remarks**" button is pressed. This remarks will also appear in the report.

5.7.- Reports printing

From the button located on the main menu it is possible to print a test report. Throughout this process the program shows a message, asking the operator to wait. The report will be printed at the predetermined Windows printer.

Figure 5-45: Message of printing.

Reports consist of 3 pages in the Recovery Voltage application and 2 pages for the Insulation Resistance application. The appearance of a report is described below:

Recovery Voltage:

- The 1st page includes identification data and technical data on the transformer tested. Figure 5-46-a.

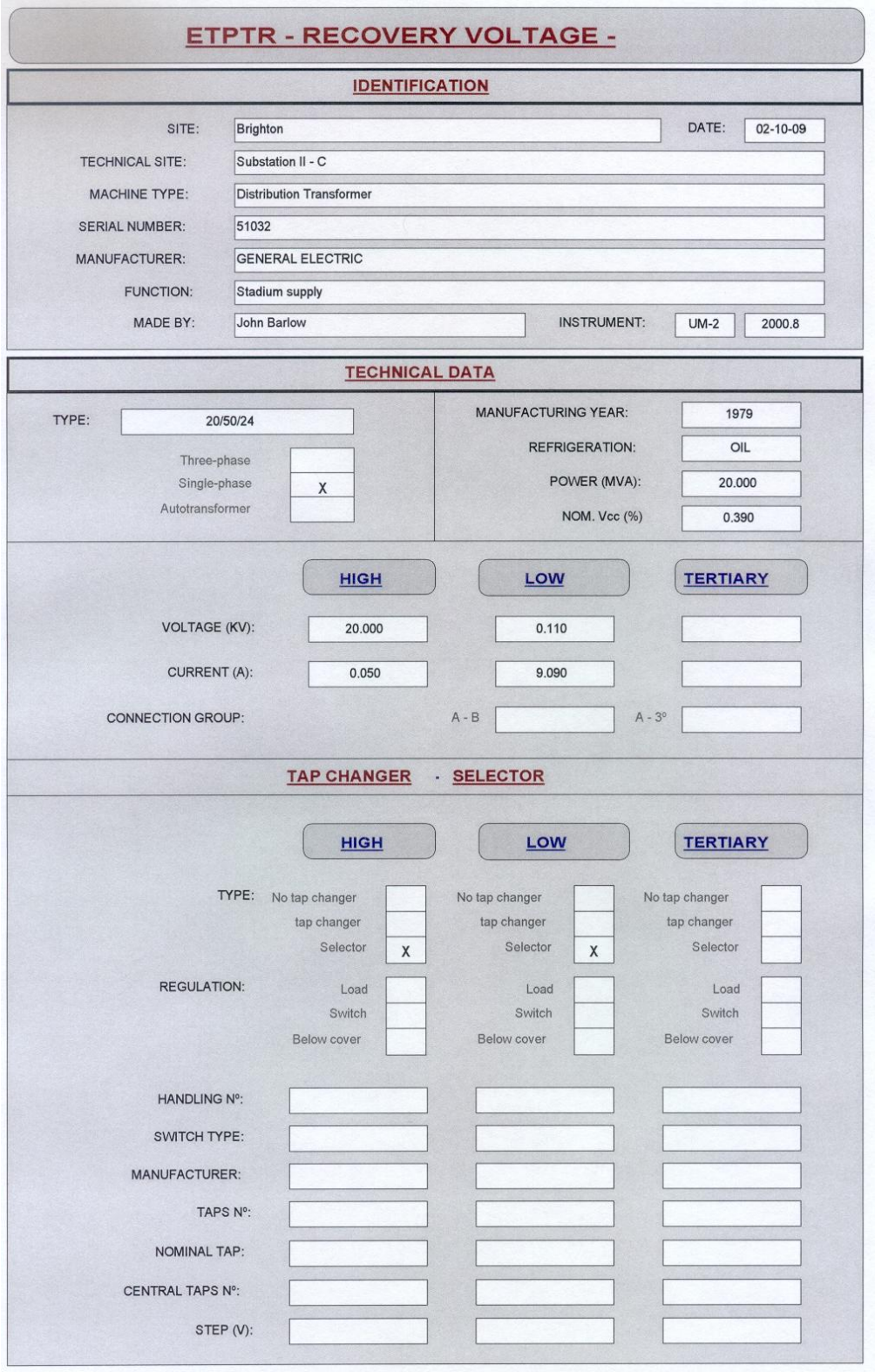
- The 2nd page includes the observations made during the test or analysis in its upper part and, in the middle, a brief summary of the measures performed. In the lower part are shown the measurements taken at different moments during the test (each sample time is twice the previous one, as from the time base established). Figure 5-47-a.

- The 3rd page shows the recovery voltage, rise time and insulation resistance graphs. Figure 5-48.

Insulation Resistance:

- The 1st page includes identification data and technical data on the transformer tested. Figure 5-46-b.

- The 2nd page includes the observations made during the test or analysis in its upper part and, in the middle, a brief summary of the measures performed. In the lower part is shown the graph of insulation resistance. Figure 5-47-b.



ETPTR - RECOVERY VOLTAGE -

IDENTIFICATION

SITE:	Brighton	DATE:	02-10-09
TECHNICAL SITE:	Substation II - C		
MACHINE TYPE:	Distribution Transformer		
SERIAL NUMBER:	51032		
MANUFACTURER:	GENERAL ELECTRIC		
FUNCTION:	Stadium supply		
MADE BY:	John Barlow	INSTRUMENT:	UM-2 / 2000.8

TECHNICAL DATA

TYPE:	20/50/24	MANUFACTURING YEAR:	1979
		REFRIGERATION:	OIL
Three-phase		POWER (MVA):	20.000
Single-phase	X	NOM. Vcc (%)	0.390
Autotransformer			

	HIGH	LOW	TERTIARY
VOLTAGE (KV):	20.000	0.110	
CURRENT (A):	0.050	9.090	
CONNECTION GROUP:		A - B	A - 3°

TAP CHANGER - SELECTOR

	HIGH	LOW	TERTIARY
TYPE:	No tap changer	No tap changer	No tap changer
	tap changer	tap changer	tap changer
	Selector X	Selector X	Selector
REGULATION:	Load	Load	Load
	Switch	Switch	Switch
	Below cover	Below cover	Below cover
HANDLING Nº:			
SWITCH TYPE:			
MANUFACTURER:			
TAPS Nº:			
NOMINAL TAP:			
CENTRAL TAPS Nº:			
STEP (V):			

Figure 5-46-a: First page of the report (Recovery Voltage).

REMARKS

Brighton, Feb. 9th 2001

- Previous test shown evident signs of humidity.

- After drying process of oil, this new shows that the transformer recovered high functionality.

REMARKS: It is adviced to review the winding (clean and fix)

Alan Waller

Workshop manager

TEST VARIABLES

TEST DATE	02-09-01	dd-mm-yy
TIME BASE	100.0	ms.
CYCLES NUMBER	14	
TEMPERATURE	20	°C
REFRIGERATION	DRY	
TEST VOLTAGE	2001	V.

TOTAL TEST TIME	00:02:20	hh:mm:ss
HV+LV/TERC+GND		
HV/LV+GND	X	
TIME CONSTANT	91.513	s.
POLARIZATION INDEX	2.2	

MEASUREMENTS

Time (sec.)	Voltage Recov. (V)
0.1	37.0
0.2	40.3
0.4	48.6
0.8	65.4
1.6	95.9
3.2	140.3
6.4	189.2
12.8	228.4
25.6	252.8
51.2	272.7
102.4	277.7
204.8	270.1
409.6	241.2
819.2	193.3

Time (sec.)	Peak Time (Sec.)
0.1	0.6
0.2	1.0
0.4	1.6
0.8	2.6
1.6	3.4
3.2	4.6
6.4	6.0
12.8	8.2
25.6	11.8
51.2	16.8
102.4	25.4
204.8	41.8
409.6	64.4
819.2	115.8

Time (minutes)	R. Insul. 20 °C (Ohms)
1	17.17
2	22.46
3	25.92
4	28.90
5	31.19
6	33.01
7	34.51
8	35.78
9	36.90
10	37.87

Figure 5-47-a: Second page of report (Recovery Voltage).

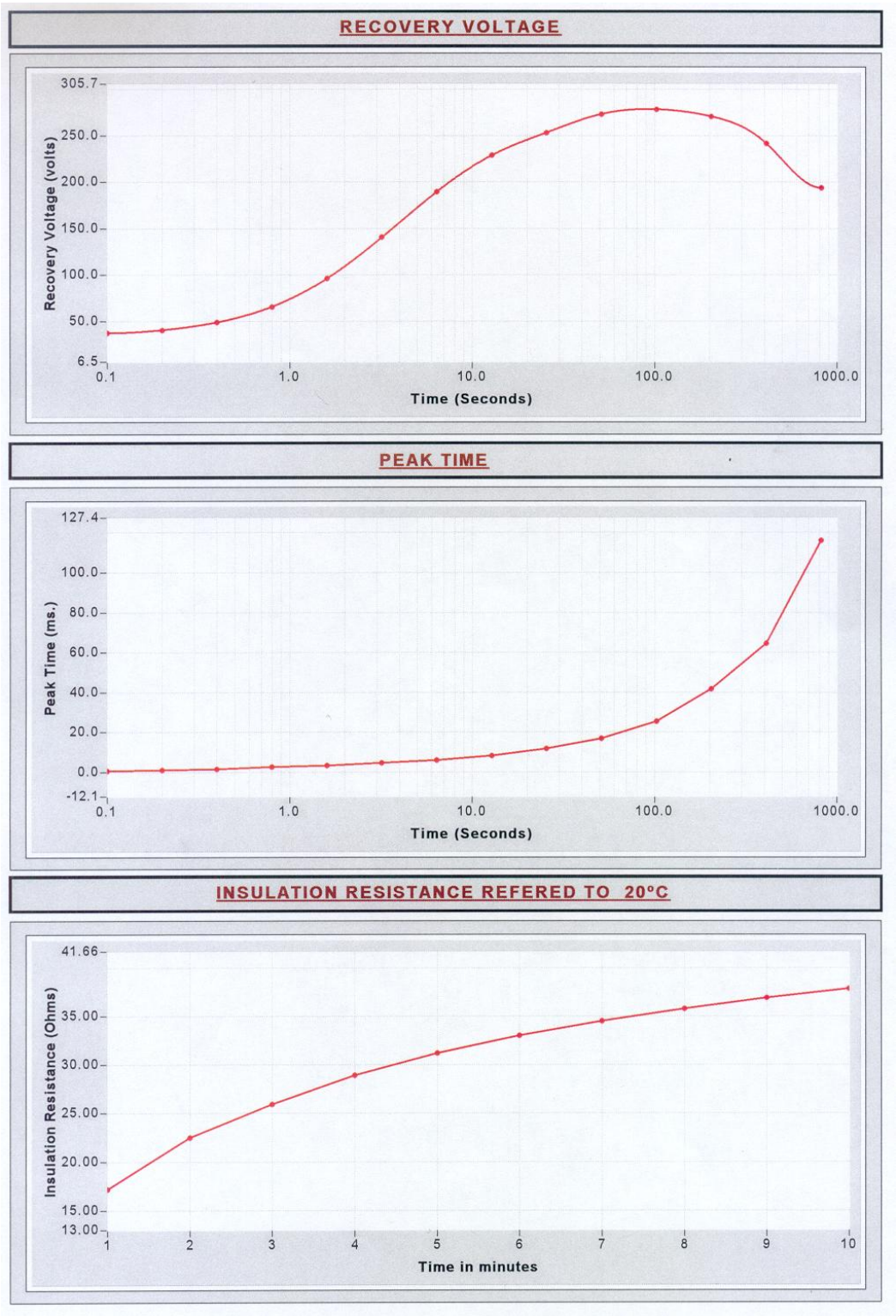
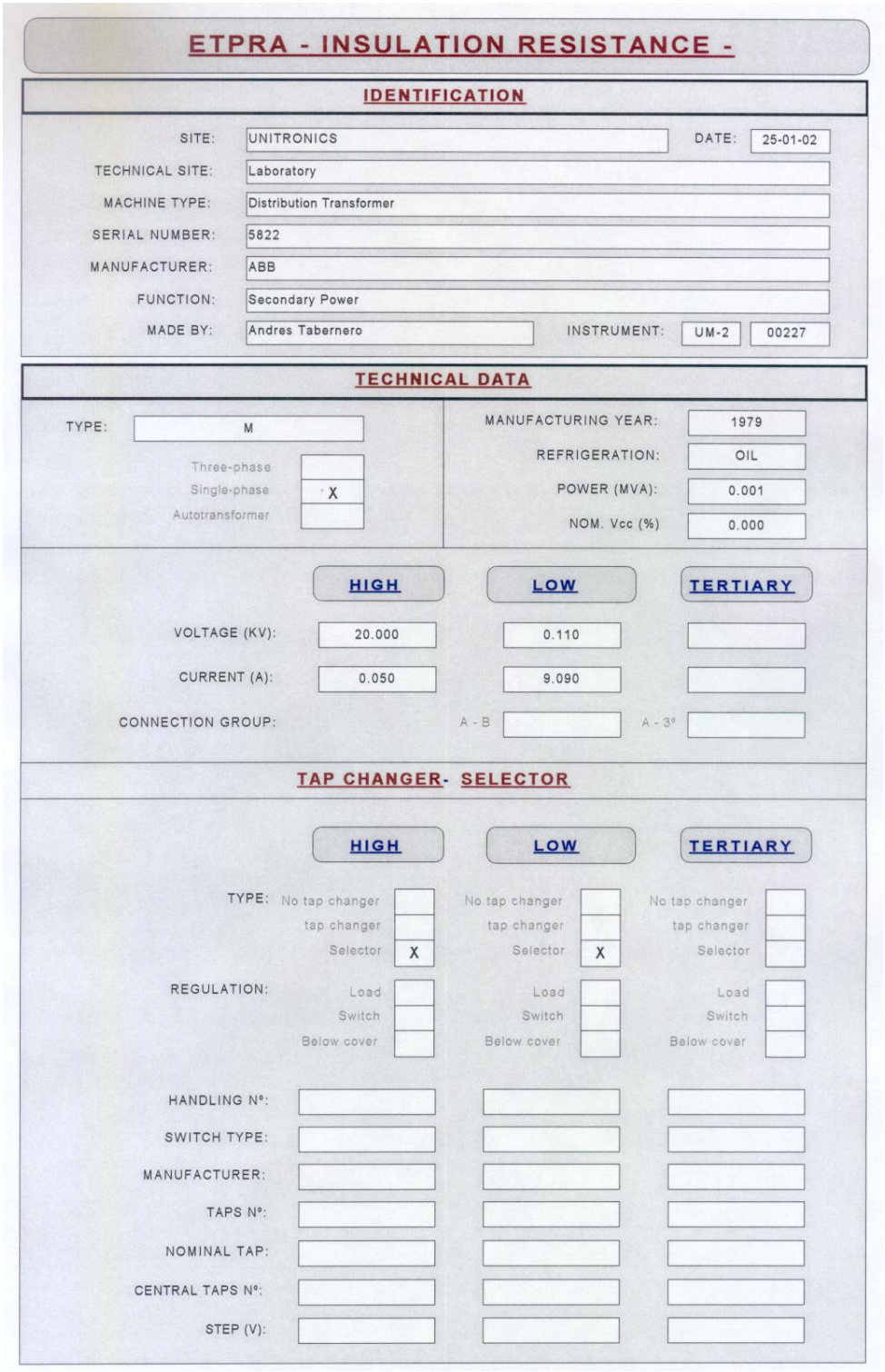


Figure 5-48: Third page of report (Recovery Voltage).



ETPRA - INSULATION RESISTANCE -

IDENTIFICATION

SITE:	UNITRONICS	DATE:	25-01-02
TECHNICAL SITE:	Laboratory		
MACHINE TYPE:	Distribution Transformer		
SERIAL NUMBER:	5822		
MANUFACTURER:	ABB		
FUNCTION:	Secondary Power		
MADE BY:	Andres Tabernero	INSTRUMENT:	UM-2 / 00227

TECHNICAL DATA

TYPE:	M	MANUFACTURING YEAR:	1979
Three-phase		REFRIGERATION:	OIL
Single-phase	X	POWER (MVA):	0.001
Autotransformer		NOM. Vcc (%)	0.000

	HIGH	LOW	TERTIARY
VOLTAGE (KV):	20.000	0.110	
CURRENT (A):	0.050	9.090	
CONNECTION GROUP:		A - B	A - 3º

TAP CHANGER- SELECTOR

	HIGH	LOW	TERTIARY
TYPE: No tap changer			
tap changer			
Selector	X	X	
REGULATION: Load			
Switch			
Below cover			
HANDLING Nº:			
SWITCH TYPE:			
MANUFACTURER:			
TAPS Nº:			
NOMINAL TAP:			
CENTRAL TAPS Nº:			
STEP (V):			

Figure 5-46-b: First page of the report (Insulation Resistance).

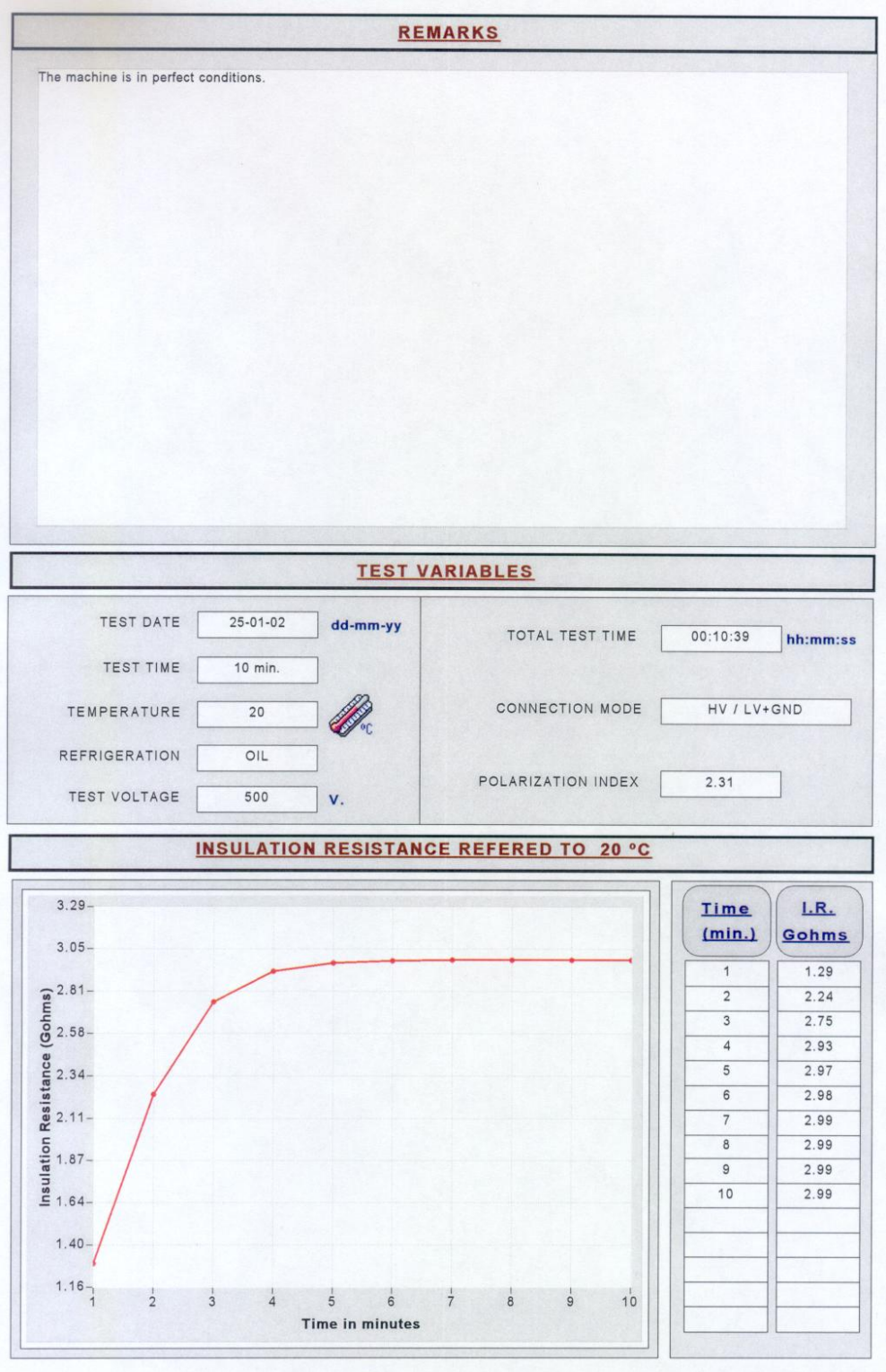


Figure 5-47-b: Second page of the report (Insulation Resistance).

5.8.- About …

By clicking on this button, a window will appear (Figure 5-49) showing the following:

- Data on the license.
- Data on the version of the program.

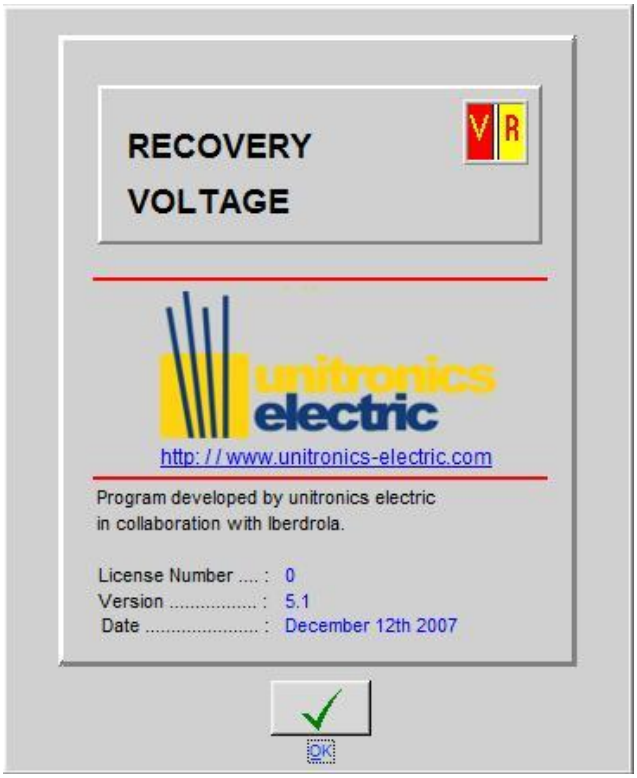


Figure 5-49: Cover screen.

If an internet connection is available, when clicking the UNITRONICS web page, the software will load the predetermined windows explorer with our web page. This cover screen also appears when the program is executed.

5.9.- Exiting

This button is used to terminate the application. The program will always check whether any data have been modified during the test or analysis. If the test has not been completed, the program will always ask if the decision is to go ahead (Figure 5-50), and if this is the case offers the possibility of saving the data entered (Figure 5-51). In affirmative case, a file will be created in the directory C:\SAGEN_WIN\Ensayos with those data (see section 5.3.1); but otherwise, the file will not be created.

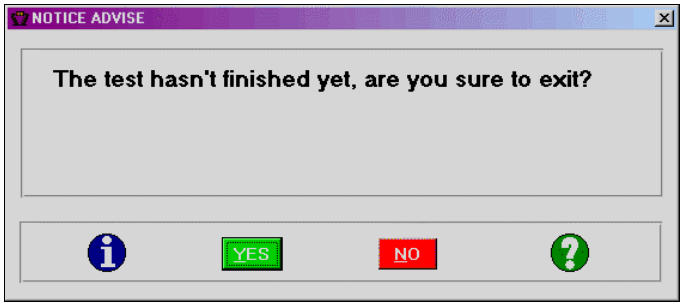


Figure 5-50: Warning for program exiting.

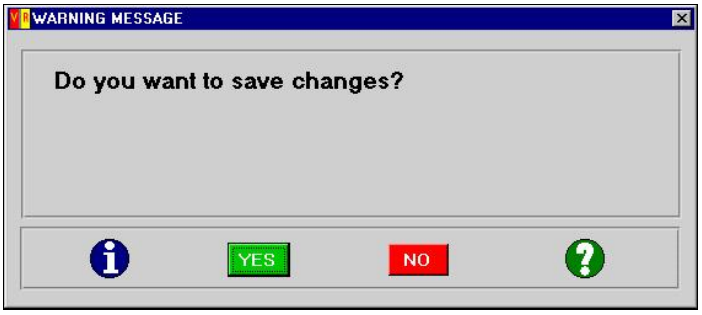


Figure 5-51: Warning of data loss.

If, an analysis was being performed and any data have been modified, the program will show the same screen when leaving the application.

Finally, the program issues a reminder to switch off the measuring unit (Figure 5-52).

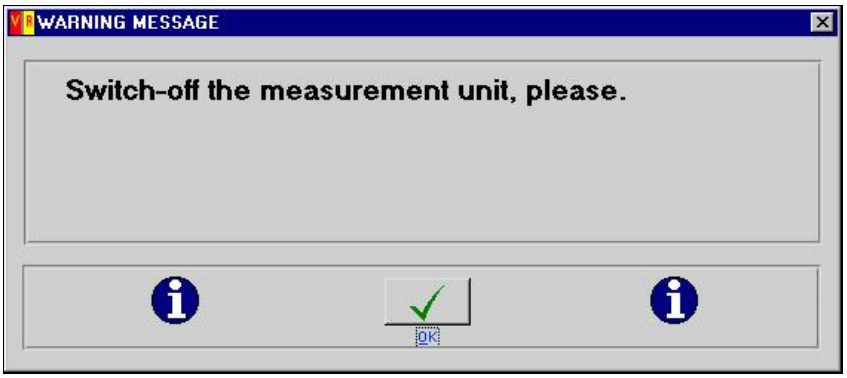


Figure 5-52: Warning to switch off the unit.

6.- EQUIPMENT MAINTENANCE

In view of the special characteristics of the equipment, this **MAY ONLY BE REPAIRED BY AUTHORIZED TECHNICAL PERSONNEL**. As mentioned in other sections, because of the special danger involved in handling high voltages with the equipment, the maintenance personnel repairing, adjusting and calibrating the equipment should be duly qualified and trained.

Opening of the equipment by non-authorized personnel implies cancellation of the warranty period.

The equipment does not contain any internal elements to be handled by the operator, and **SHOULD IN NO CASE BE OPENED, DUE TO THE SERIOUS DANGER OF ELECTRICAL SHOCK**.

The maintenance of the equipment is very straightforward and consists simply of keeping it in good condition externally and making sure the cables supplied are also in good condition. If the fuse blows, it should be replaced with one of identical characteristics, as described in section 6.4 (Replacement of fuses). If a fuse should blow continuously, the equipment should be sent for repair (see section 8.1: Return for calibration/repair).

In order to maintain its values of accuracy, the equipment should be calibrated at least once a year.

Special care should be taken to prevent the unit from getting wet, and it should be protected against rain if necessary. In the event of extreme levels of humidity or temperatures outside the margins, the measures provided by the equipment will not be valid, and it will be necessary to wait for the equipment to regain its operability. For example, leave it to dry if it has got wet. Likewise, changes in the situation of the equipment, especially if stored, may cause rapid variations in temperature causing humidity to appear as a result of condensation.

6.1.- Cleaning of equipment

ATTENTION: Always turn off the power switch (4) and disconnect the supply cables from the socket (5) before cleaning the equipment.

Use the following to clean the equipment and cables:

- a soft dry cloth, if the equipment is not particularly dirty.
- a cloth soaked in a diluted neutral cleaning product if the equipment is very dirty or has been in store for some time. After checking that the shell is completely dry, use a soft dry cloth to clean.

ATENTION: Never use alcohol or any other abrasive product to clean the shell, since this may cause damage or decolouring.

6.2.- Care of cables

The UM2B unit is capable of producing high voltages, as a result of which THE CABLES SHOULD BE IN PERFECT ORDER, TO AVOID THE DANGER OF ELECTRICAL SHOCK OR ERRORS AND INACCURACIES IN MEASUREMENT.

The cables and their condition should be periodically checked in order to detect beforehand any deterioration or breakage that might cause situations of danger for the operators and/or malfunctioning of the equipment. If the cables are damaged, they should be sent for repair to an authorized technical service or new cables should be acquired (see chapter 8). This is applicable also to the cable and unit connectors.

Special care should be taken with the serial cable for connection of the PC, since it is in charge of controlling the unit.

It is very important not to tread on or move the cables during testing, since this might alter the measurements, especially at low current values (very high measured resistances).

For properly measuring, the cables must be completely stretched until the measurement point without creases, or anyway, that these have a radius not inferior than 200 mm.

6.3.- Check of high voltage cables

To check the HIGH VOLTAGE cable they should be disconnected so of the unit like of the equipment under test. The equipment UM2B is able to provide very high voltage, then THE CABLES SHOULD BE IN PERFECT STATE TO AVOID ELECTRIC SHOCKS OR ERRORS AND IMPRECISION IN THE MEASURES.

When an anomaly is detected in the cables or you want to verify its correct state, you can do this simple test.

We only need a multimeter that indicates us the electric continuity or discontinuity. To check each cable we will come in the following way:

1. Disconnect the high voltage cable in their both ends.

2. Check the discontinuity between active and body. We take the high voltage's connector that goes into the UM2B unit. We place one multimeter test tip in contact with the connector's interior tip (active) and the other multimeter test tip in contact with the connector's metallic cover. Multimeter should say discontinuity.

Figure 6-1: Discontinuity check between active and body.

3. Check the continuity between cable ends. We take the high voltage's connector that goes into the UM2B unit and the clip of the other cable end. We place one multimeter test tips in contact with the connector's interior tip (active) and the other multimeter test tips in contact with the clamp that is in the other cable end. The multimeter should say continuity.

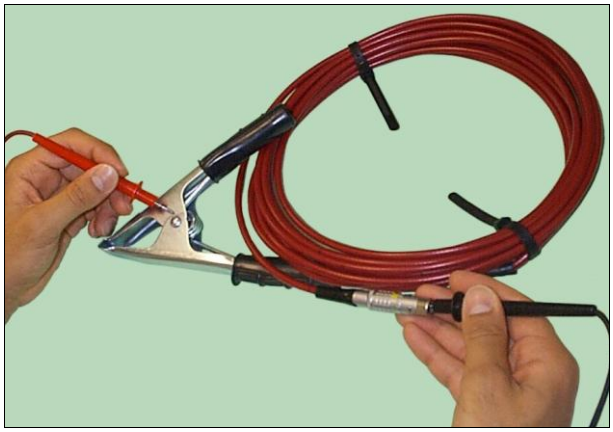


Figure 6-2: Continuity check between cable ends.

4. Previous checks could be performed by the user, but it should also be checked dielectric rigidity and insulation resistance of the cable should they be damaged. This two last verifications only could be performed by the technical service.

6.4.- Replacing fuse

ATTENTION: Before changing the fuse, ALWAYS unplug the power cable. Always use fuses of the value and type specified (see chapter 9: Specifications)**.**

In order to avoid possible supply voltage peaks that might damage the UM2B, the unit incorporates a fuse, housed in the lower part of the mains connector (5). The fuse-holder may be slid out by hand or using a small screwdriver. Inside (inner) is the operating fuse and, in an adjacent compartment (outer), a spare.

The very arrangement of the fuse-holder makes it necessary to disconnect the power cable. Nevertheless, great care should be taken to ensure safety, and the cables should be disconnected from the equipment being tested. Also, the UM2B should be moved away from this equipment.

After having carried out the aforementioned safety processes, replace the fuse as follows:

1	Turn off the switch on the rear panel
2	Disconnect the cables from the equipment being tested.
3	Disconnect the power cable.
4	Open the fuse-holder.
5	Remove the blown fuse (the inner one).
6	Insert the adequate spare fuse.
7	Close the fuse-holder.

6.5.- Storage and transport

Changes in the location of the equipment, especially if in store, may cause rapid variations in temperature that may cause humidity to appear inside the equipment. This may give rise to erroneous readings or to short-circuiting in the worst of cases.

Before storing the equipment it is advisable to clean it. Likewise, it is recommended that all the different elements of the equipment be kept in appropriate storage containers.

The place chosen for storage of the equipment should:

- Not be exposed to direct sunlight.
- Not be exposed to high levels of dust.
- Not be exposed to high levels of humidity.
- Not be exposed to active gases.
- Not be exposed to extreme temperatures.

The recommended conditions for storage are describe in the system specifications (See chapter 9.3 Specification).

In areas of very high levels of humidity desiccant bags should be used.

If the equipment has been in storage for a very long period of time, it is advisable to send it to an authorized technical service for calibration.

When transporting the equipment for the performance of tests in different locations, appropriate transport containers should be used. Likewise, the equipment should not be subjected to continuous vibrations or to knocks.

Transport should be accomplished under the storage conditions recommended above.

7.- TROUBLESHOOTING

SYMPTOM	PROBLEM	SOLUTION
The power switch (4) is turned on but the power indicator (2) does not light up.	Power cable not properly connected or there is no power supply.	Connect properly or check the supply.
	The fuse has blown.	Replace fuse (see section 6.4). If the problem persists, send the equipment to an authorized technical service.
	The equipment is faulty.	Send the equipment to an authorized technical service.
There is voltage in the cables but none of the test voltage indicating LED's (1) lights up.	One of the indicators has blown.	Send the equipment to an authorized technical service.
	The equipment is faulty.	Send the equipment to an authorized technical service.
	One external equipment sets his voltage on the cables.	Review the measurement's conditions and that the machine is fully discharged.
The equipment generates voltage but this is not present in the cables.	The high voltage cables are not properly connected.	Connect properly changing previously to zero the voltage.
	The high voltage cables are in poor condition.	Contact an authorized technical service.
	The equipment is faulty.	Send the equipment to an authorized technical service.

SYMPTOM	PROBLEM	SOLUTION
On executing the program, the **Test** option is disabled.	The hardware key dongle is not in place.	Place the key in the parallel port of the PC, suitably oriented.
	Not has installed the file of the diskette key	Install the program inserting the diskette key when concluding the installation again.
The connecting cable is connected between the UM2B and the PC, but the connections screen (Section 5.3.4) indicates the contrary	The series cable is not properly connected.	Connect properly or review in "configuration" if the COMX port is the correct one.
	The serial cable is damaged.	Contact an authorized technical service.
The message: "UM2B does not respond" appears on the screen	The unit is not turned on.	Turn on the unit.
	The serial cable is not properly connected.	Connect properly or review in "configuration" if the COMX port is the correct one.
Short-circuit is detected during the test	Measurement cables are damaged.	Check measurement cables.
	Equipment under test is damaged.	If proper, repeat the test to secure the fault.
	Short circuit cables among phases of every winding are in contact with chassis or its isolation is deficient.	Review the wiring.
Irregularities are detected in the measurement	Short circuit cables among phases of every winding are in contact with chassis or its isolation is deficient.	Review the wiring.
	Cables were stepped, damaged or treaded.	Repeat the test and check that cables are not threaded or moved.

SYMPTOM	PROBLEM	SOLUTION
Irregularities are detected in the measurement.	Machine with residual charges.	Restart the test grounding the phases the recommended time.
	Equipment under test is damaged or has any insulation failure.	If proper, repeat the test to secure the fault.
The message: “A SHORT CIRCUIT EXIST. Check the connection of the unit with the machine ” appears on the screen.	The current that circulates on measurement cables is very high (delayed measurement bigger than 3mA) and it is possible that a short circuit exists in the machine to measure, measure connections or cables of high.	*Machine to test:* Damaged machine. Insulation Resistance is very low.
		Measure connections: Check that test clamps are not in short circuit or that the connections between bushing and chassis are properly insulated.
		High voltage Cables: Check high voltage cables according to the section 6.3.

Table 7-1

* The numbers in brackets refer to Figure 3-9 (section 3.3).
* To contact an authorized technical service or return the equipment, refer to section 8.

8.- TECHNICAL SUPPORT

Please provide the following information when contacting our technical service:

- Equipment model.
- Serial number shown on rear panel.
- Description of fault.
- Name and telephone number of the operator in charge of the equipment and of a person responsible for it.

8.1- Return for calibration/repair

If, after having revised chapter 7 (Troubleshooting) the equipment is concluded to need repair / calibration, it is essential that the following instructions are adhered to:

1. Copy and fill in the sheets that appear on the following pages and attach them to the equipment.
2. Pack the equipment or accessories using an appropriate transport container.

When returning the equipment for repair, the most appropriate thing is to send the complete system; i.e., the measuring unit and cables. In any case, contact the technical service.

CLIENT DATA		
COMPANY:		**Client No:**
Address:		
City:	**P.C.**:	**Province**:
Contact person:		**e-mail**:
Telephone:	**Fax**:	

EQUIPMENT DATA
UM2B serial No:
Date of acquisition:
Date of last adjustment/calibration:
Date of last revision/repair:

Reason for returning

☐ Calibration | ☐ Calibration certificate required

☐ Repair

(Fill in only in case of problems)

Is the equipment under warranty?

☐ Yes

☐ No

Date on which fault occurred:

Fault detected in equipment

☐ Power LED does not light up

☐ One of the test voltage indicator LED's does not light up

☐ Fuse has blown repeatedly

☐ No connection established between PC and equipment.

☐ PC communications cable deteriorated

☐ High voltage cables deteriorated

☐ Equipment broken down

☐ Others

Description of fault:
Materials returned:
_____ , on __ of _____ of the year _____.

Table 8-1

8.2.- Ordering spares

Please contact the Sales Department.

8.3.- Observations

The UM2B equipment has been developed and tested under the same conditions and in the same installations as those in which it will operate. Nevertheless, it is always good to gain insight into the degree of satisfaction of the customer and to know what new performance characteristics he would like to see or which he would eliminate, with a view to developing future system hardware / software improvements. If you have any observation / suggestion to make as regards the software, hardware, cabling, operation, characteristics, etc., please photocopy the following 2 sheets, fill them in and send them to the corresponding Sales Department.

COMPANY: **Customer No:**

Address:

City: **P.C.**: **Province**:

Contact person: **e-mail**:

Telephone: **Fax**:

UM2B serial No:

Date of acquisition:

Degree of satisfaction

☐ Very satisfied ☐ Satisfied ☐ Dissatisfied

☐ Fairly satisfied ☐ Not very satisfied ☐ Very dissatisfied

What safety elements would you add?

What new calculations should it perform?

What standard/optional elements would you add? What elements would you remove? What defects does the system have?
_____ , on ____ of _____ of the year _____ .

Table 8-2

8.4.- Authorized representatives and technical services

UNITRONICS:

- Sales Department:

  UNITRONICS
  Sales Department
  Avenida Fuente Nueva. 5
  28709 San Sebastián de los Reyes
  Madrid, SPAIN.
  Tel.: +34-91-540 01 25
  Fax: +34-91-540 10 68
  URL: http://www.unitronics-electric.com

- Technical Service:

  UNITRONICS
  Technical Service
  Avenida Fuente Nueva. 5
  28709 San Sebastián de los Reyes
  Madrid, SPAIN.
  Tel.: +34-91-540 01 25
  Fax: +34-91-653 98 10
  URL: http://www.unitronics-electric.com

9.- SPECIFICATIONS

9.1.- Electrical.

- **Power requirements:**

  Depending on version:

  230V~ ±10% 50/60 Hz ± 5%
  115V~ ±10% 50/60 Hz ± 5%
  Installation Category II, as to IEC 664-1

Note: The power configuration of the units is fixed from manufacturing.

Consumption: 60 VA (máx.)

- **Fuses**

	Location	Name	Supply	Value and kind
Replaceable by operator.	Rear Panel	FUS 1	115 V	**630 mA T** 250 Vac (20x5)
			230 V	**315 mA T** 250 Vac (20x5)
Non Replaceable by operator	Microcontroller	F1	---	**630 mA T** 250 Vac TR5
		F2		
	Main Board	F1	115 V	**500 mA T** 250Vac TR5
			230 V	**250 mA T** 250Vac TR5
		F2	115 V	**250 mA T** 250Vac TR5
			230 V	**160 mA T** 250Vac TR5
		F3	---	**160 mA F** 250 Vac TR5
		F4	---	**160 mA F** 250 Vac TR5
		F5	---	**200 mA T** 250Vac TR5
		F6		
		F7	---	**315 mA T** 250Vac TR5
		F8		

Table 9-1: Fuses required.

All fuses must be **homologated and approved for 250 Vac.**

9.2.- Technical characteristics:

Dimension	Value	Unit
Length	40	Cm
Width	45	Cm
Height	13.5	Cm
Weight	10	Kg

Table 9.2: Technical characteristics..

9.3.- Measurement Scales.

- **Technical specifications:**

Characteristic	Conditions	Range	Accuracy	Resolution
Programmed and generated test voltage		500V/1000V/1500V/ 2000V Max. current 5 mA	±1% ±1 digits	1V
Test voltage measurement		0 ... 2000 V	±1% ±3 digits	1V
Recovery voltage measurement		0 ... 1000 V	±3% ±3 digits	1V
Isolation measurement	@ 2000 V	1M Ω ... 100 GΩ	±3% ±3 digits	
	@ 2000 V	100 GΩ ... 200 GΩ	±5% ±3 digits	
	@ 2000 V	200 GΩ ... 2 TΩ	±20% ±3 digits	
Operation temperature		5 - 35ºC 41 – 95 ºF		
Operation humidity		10 - 80%		
Storage temperature		5 - 75ºC 41- 167 ºF		
Storage humidity		5 - 80%		

Table 9-3: Unit specifications.

"In determined conditions of presence of transitory phenomenon with respect to earth it may appear variations in the measure. Then, the test should be re-initialized or repeated."

CE

The equipment complies with EU Directives applicable to electric and electronic equipment destined to industrial environments with category II of installation.

9.4.- Minimum control PC requirements

- ✓ PC: Based on Pentium 200 MHz processor or better.
- ✓ Operating System: MS Windows 95, MS Windows 98 or MS Windows NT 4 (with Service Pack 4 or better).
- ✓ RAM: 32 MB RAM.
- ✓ VGA colour monitor.
- ✓ Floppy disk drive
- ✓ CD-ROM drive.

9.5.- Additional specifications

▪ **Other characteristics:**

- Power on indicator.
- Luminous test voltage indicator (4 values).
- Luminous indicator of active communication with PC.
- Control of output voltage by use of programmable voltage source controlled from PC.

▪ **Parameters used:**

Recovery voltage.
Insulation resistance.
Polarization index.
Time constant.

APPENDIX A.- "CE" CONFORMITY DECLARATION

"CE" CONFORMITY DECLARATION

UNITRONICS, S.A.U.
Plaza España 18, 9th fl. off. 9
28008 Madrid SPAIN
VAT number: ES A-28121572
Tel.: 34 (1) 542 52 04
Fax: 34 (1) 542 78 96

UNITRONICS

We declare on our own responsability the conformity of the product:

Instrument Recovery Voltage Tester. Dielectric test with variable time voltage step.
Equipment UM2. Manufacturer UNITRONICS. Model UM2B.

at which this declaration refers, with the disposals of the following directives and applicable standards:

- CE Marking directive. DC 93/68/CEE
- Electromagnetic compatibility directive: DC 89/336/CEE
  Applicable armonized standards:
  - EN 61326-1 (97)
  - CISPR 22 (93)
  - IEC 1000-3-2 (95)
  - IEC 1000-3-3 (95)
  - IEC 1000-4-2 (95)
  - IEC 1000-4-3 (95)
  - IEC 1000-4-4 (95)
  - IEC 1000-4-5 (95)
  - IEC 1000-4-6 (95)
  - IEC 1000-4-11 (94)

- Low voltage directive: DC 73/23/CEE
  Applicable armonized standards:
  - UNE-EN 61010-1 (96)

Authorised Signatory

Madrid, September 28th of 2001

UNITRONICS, S.A.U.
Plaza de España, 18 pl. 9ª
tlf 915 40 01 25
28008 MADRID

Jaime Carreras de la Fuente
Manager:

Corporate seal:

APPENDIX B.- CONTROL SOFTWARE INSTALLATION

The documentation referred to the control software installation manual UM2B can be found in file SETUP_TR_ING.

APPENDIX C.- OTHER UNITRONICS EQUIPMENT

UNITRONICS provides a set of tools oriented towards the predictive maintenance of electrical installations that use common hardware and specific software applications for the performance of different measuring functions.

All the software applications that make up this set have been developed by UNITRONICS with a view to facilitating maintenance tasks; consequently, the different programs completely guide the actions of the operator, without the need for the latter to have in-depth computer knowledge. Subsequently, during the results and trends analysis phase, the software itself sometimes provides an initial, direct and basic evaluation of the tests performed.

At the same time, and because of the importance of correct data management, all the measurements performed using the set of tools are encompassed in a common database, such that recovering the tests performed on any machine is a simple matter.

All the hardware and applications have been developed by the UNITRONICS Design Department, thus providing a guaranteed maintenance service. In developing all these systems, actual tests have been carried out at the same installations in which the equipment is later to operate, thus ensuring suitable operation and leaving open the possibility for future modifications based on the experience of the users of our equipment.

The availability of different applications on one same hardware support implies a series of advantages with respect to traditional instrumentation, the following being particularly outstanding:

- Unification of measuring systems.
- Common database for all tests.
- Hardware items common to all the systems.
- Reduction of instrumentation costs.
- Ease in handling, guided operation.
- Instructions and menus in English.
- Straightforward maintenance and possibility for modifications.
- Graphic results display.
- Preliminary automatic results assessment.
- Trends analysis.
- Simplification of calculations.

C.1.- Available applications

EDAIII: analysis of motor and alternator insulations (Figure C-1).

Figure C-1: Photograph of EDAIII equipment.

ETP: evaluation of power transformers.

UM1B: measurement of transformation ratio (Figure C-2).

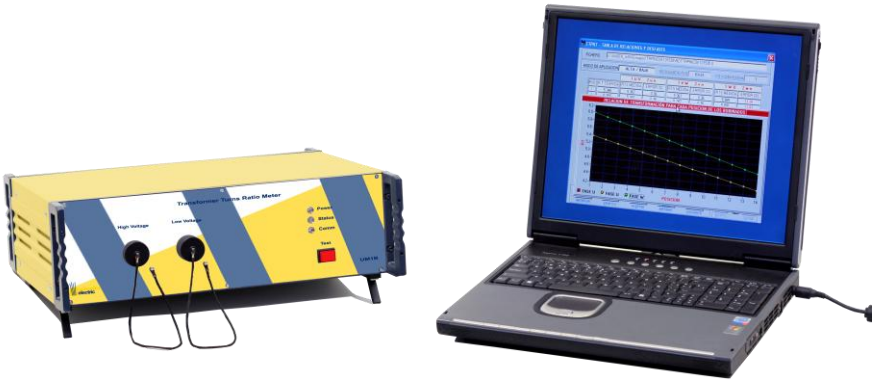


Figure C-2: Photograph of UM1B equipment.

UM2B: measurement of recovery voltage and insulation (Figure C-3).

Figure C-3: Photograph of UM2B equipment.

UM3B: measurement of winding resistance (Figure C-4).

Figure C-4: Photograph of UM3B equipment.

UM5B: Short circuit impedance (Figure C-5).

Figure C-5: Photograph of UM5B equipment.

RAFVDM: Power Socket Supply / earth detecting (Figure C-6).

Figure C-6: Photograph of RAFVDM equipment.

EDA_DIAGHELP: Expert software of diagnosis for rotating machines (Figure C-7).

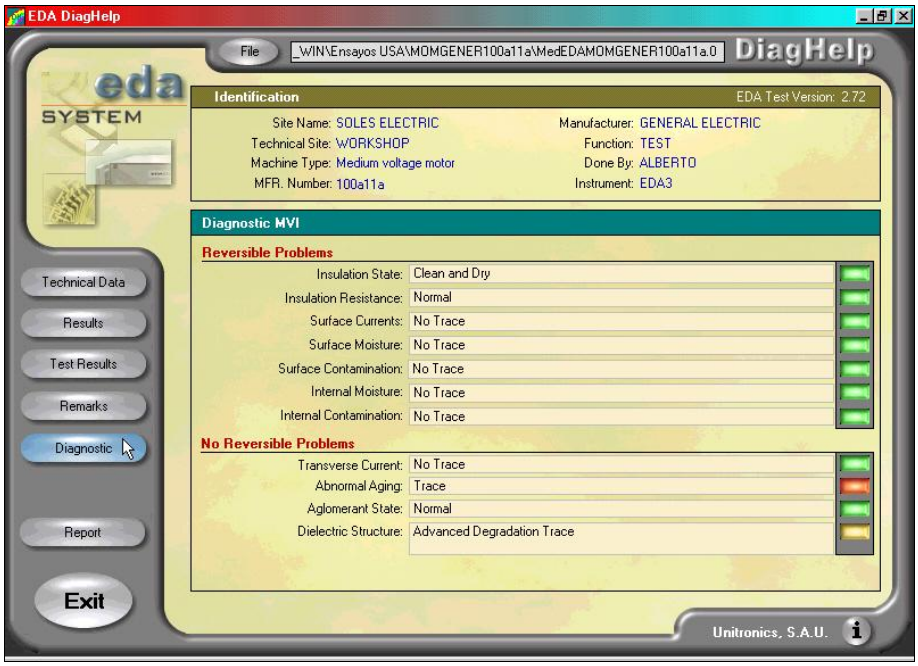


Figure C-7: Screen of the application Diag_Help.

EDA_TRENDS: Expert software of trends for rotating machines (Figure C-8).

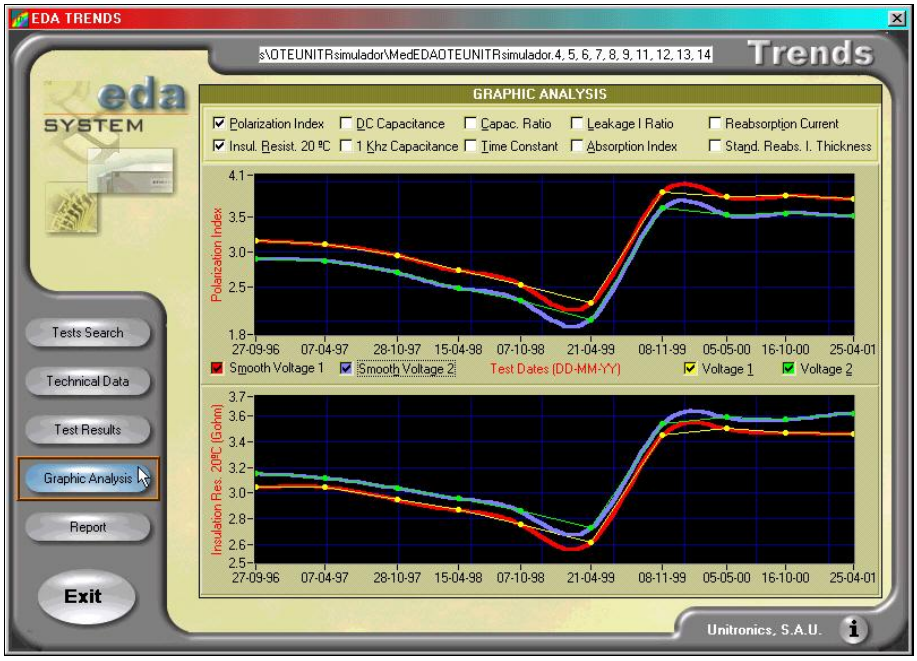


Figure C-8: Screen of the application Trends.

ETP_DIAGHELP: Expert software of diagnosis for transformers (Figure C-9).

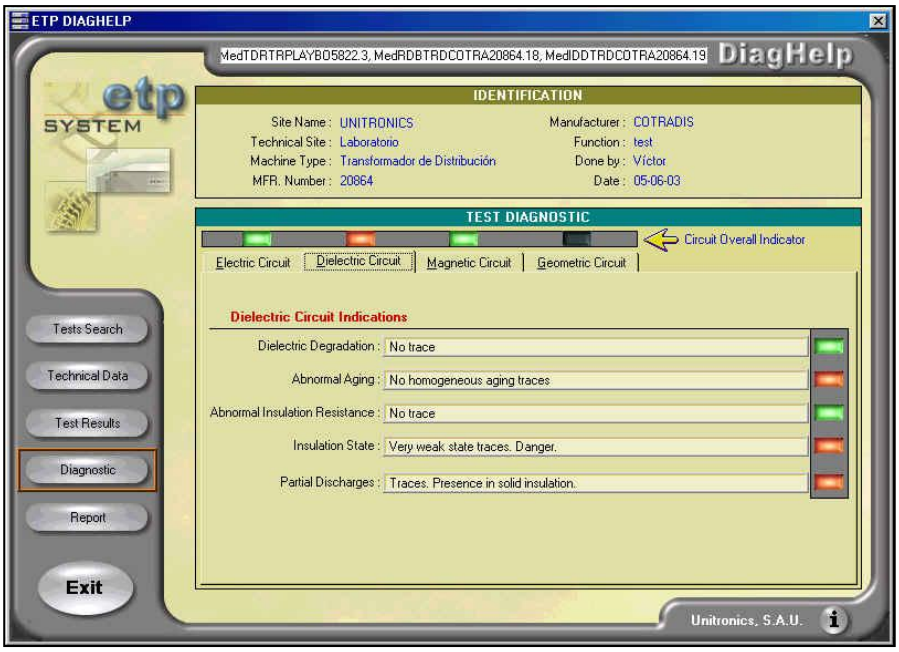


Figure C-9: Screen of the application DiagHelp.

ETP_TRENDS: Expert software of trends for transformers (Figure C-10).

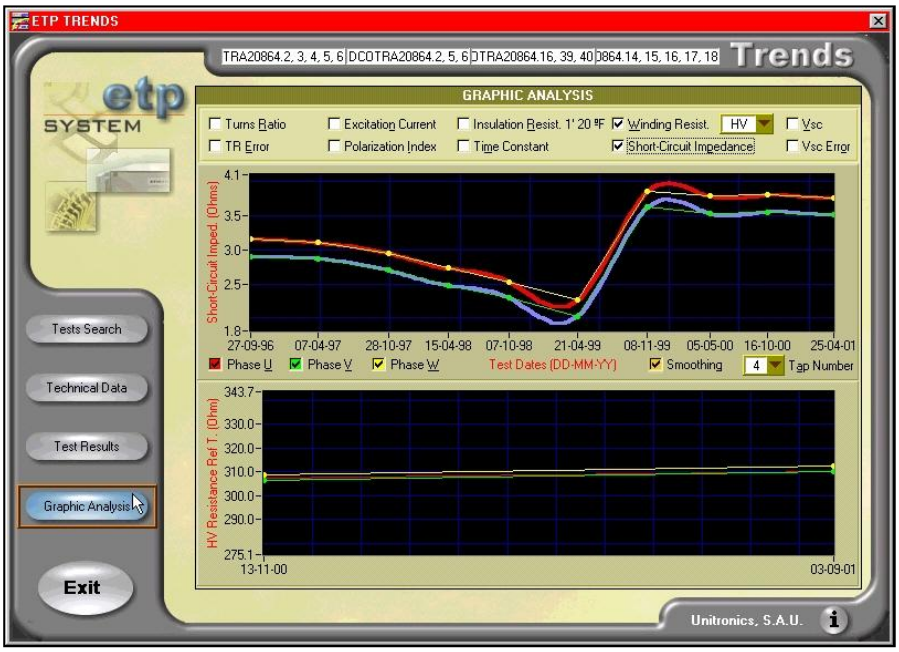


Figure C-10: Screen of the application Trends.

APPENDIX D.- GLOSSARY

A series of terms habitually used with the equipment are listed below, along with a description of their function in this area of work.

Adjuster

Device capable of modifying the number of turns of a transformer, and therefore of changing its transformation ratio. The difference between this and a regulator is that it is normally fixed at a given position during manufacturing.

Admissible State

Admissible condition of an item for a specific use. This may never be lower than the condition required for such use by the official and technical regulations. Equivalent to the term Permissible condition.

Agglutinant:

Substance that allows to fix a dielectric in a surface.

Alternator

Set of apparatus combined to transform kinetic energy into alternating current.

Assembly

Functional unit forming part of an item and made up in turn of components (motor, turbine).

Autotransformer

Device capable of changing the level of magnitude between input and output, similar to a transformer, but with the difference that it consists of a single coil with an intermediate tap, as a result of which there is a common part between the coils.

Availability

Capacity of an item to perform its function at a given moment or over a given period of time, under defined conditions and at a defined level of performance.

Breakdown

Disappearance of the capacity of an item to perform its specific function. Equivalent to the term failure.

Bridge

Resistance of low value used to form short-circuits.

Bushing

Conducting element aimed at connecting a winding to external conductors.

Capacity

Physical property that allows for the storage of electrical charges between two insulated conductors (separated by a dielectric) subjected to different potential.

Chassis

Set of elements forming the physical support for a system or item of equipment.

Cleaning

Removal or reduction of dirt, slag, waste material, rust or incrustations in order for an item to work under better conditions of use.

Coil

Conducting assembly in charge of inductive magnetic coupling.

Component

Unit belonging to an assembly, that is not generally functional by itself, and is formed by parts (turbine rotor, bearing, cylinder of an engine).

Conductor

Material that allows an electrical current to pass continuously when subjected to a difference in potential.

Corrosion

Destruction of a material, usually a metal, or of its properties, as a result of reaction with a medium.

Corrective Maintenance

Maintenance carried out on an item once a breakdown has occurred, returning it to its Admissible Condition for use. Corrective maintenance may or may not be scheduled.

Current

Movement of electrons between two points of a conductor due to the difference in potential between both.

Delta connection (D connection)

Connection in series of the phase windings of a three-phase transformer, or of each winding of the same voltage assigned to single phase transformers constituting a three-phase bank, performed such that a closed circuit is formed.

Defect

Alteration of the conditions of an item of sufficient importance to cause its normal, or reasonably foreseeable, function to become unsatisfactory.

Diagnosis

Deduction of the nature of a failure based on the symptoms detected.

Dielectric absorption.

The property of dielectrics to regain some charge following the removal of momentary short-circuits. The dielectric acts as though throughout the charging period it had become impregnated with a charge that remains during and after the discharging period. This charge emanates again from the dielectric, causing a voltage to reappear.

The explanation of this is due to the movement of dipoles and mobile ions in a dielectric material exposed to an electrical field. It is a measure of the quantity of impurities present inside the dielectric.

Dielectric rigidity or breakdown potential

Measurement of the resistance of a dielectric to dielectric rupture under the influence of strong electrical fields, normally expressed in volts per centimeter.

Equipment

Complex unit of higher order made up of assemblies, components and parts, grouped to form a functional system. Equivalent to the term machine.

Emergency Maintenance

Corrective maintenance required to avoid serious consequences.

Failure

Loss of the capacity of an item to perform its specific function. Equivalent to the term breakdown.

Fuse

Device protecting apparatus against overload and short-circuit conditions. It contains a small cross-section conductor that melts when subjected to an excessively intense current.

Ground

Point of zero potential. Not to be confused with mass.

History file

Record of events, breakdowns, repairs and actuations in general concerning a given item.

Installation

System made up of items that form a functional production or service unit.

Insulation

Substance of low electrical conductivity that contains few free charges capable of withstanding the influence of an electrical field. The flow of current through such substances may be considered insignificant.

Insulation resistance

Resistance of an insulating material to the passage of a current, measured in the direction in which the insulation is to be ensured.

Item

System, sub-system, installation, plant, machine, equipment, structure, building, assembly, component or part that may be considered individually and that allows for separate revision or testing.

LED

Abbreviation of Light Emitting Diode. This is a diode that emits light of a certain wavelength when polarized.

Machine

Complex unit of higher order made up of assemblies, components and parts, grouped to form a functional system. Equivalent to the term equipment.

Magnetic package

All the elements that make up the electromagnetic coupler that transforms electrical energy into magnetic energy, for this in turn to be transformed into mechanical energy (rotating machines) or once again into electricity (transformers).

Maintenance

Set of technical and administrative activities aimed at conserving or replacing an item in/to conditions allowing it to perform its function.

Maintenance Policy

Strategy governing the decisions of the management of a maintenance organization.

Mass

Point of reference in an electrical circuit.

Modification

Partial change of the design of an item.

Neutral

Point of a symmetrical system of voltages where the potential is normally zero.

Non-destructive test

Test performed on a machine applying a voltage lower than the manufacturer's recommended maximum.

Part

Parts making up a component (gaskets, bolts).

Permissible condition

The admissible state of an item for a specific use. This may never be below that required by the official and technical regulations for each such use. Equivalent to the term Admissible State.

Phase

Each of the single phase currents that make up a multiple phase system. This term usually includes the conductors, windings, etc.

Phase winding

Set of spirals forming a multiple phase winding.

Power

Product of the voltage applied to a circuit by the current circulating in it. This is measured in watts (W).

Predictive Maintenance

Preventive maintenance based on knowledge of the status of an item through the periodic or continuous measurement of a significant parameter. The intervention of Maintenance is conditioned to the prompt detection of symptoms of failure.

Preventive Maintenance

Maintenance consisting of performing certain repairs or changes to components or parts, on the basis of previously established time intervals or certain criteria, to reduce the probability of failure or loss of performance of an item. This is always scheduled.

Rack

Frame supporting electronic equipment.

Recovery voltage.

It is the voltage that appears on the terminals of a dielectric previous charged, and it was applied a short circuit in it for a determined time.

Report

Documentation resulting from the performance of a test.

Resistance

Opposition of a conductor to the flow of current.

Regulator

Device capable of modifying the number of turns of a transformer, and thus capable of changing its transformation ratio.

RPM

Revolutions Per Minute. This indicates the working regime of a machine.

Rotating machine

Set of apparatus combined to receive a certain form of energy and replace it with another more adequate to produce a certain effect. One of these forms would be kinetic energy. There are, therefore, generators and AC and DC motors and rotating converters.

Rotor

Rotating part of a machine.

Rupture

Breakdown causing the unavailability of an item.

Scheduled Maintenance

Preventive maintenance performed at previously determined intervals of time, number of operations, stroke, etc.

Short-circuit

The joining of two points subjected to different voltages across a very small resistance (bridge). The current reaches its maximum value.

Short-circuit voltage

This is the voltage that needs to be applied to the *high voltage* winding in order for the nominal current to flow through the *low voltage* winding when the latter is short-circuited.

Spare

Part, component, assembly, equipment or machine belonging to an item of higher order and capable of being replaced due to breakage, wear or consumption.

Stator

Fixed part of a rotating electrical machine, in which the rotor turns.

Test

Essay performed on an item to assess one of its characteristics.

Transformation ratio

Ratio of the number of spirals in a secondary coil to that of a primary. In practice, this is the ratio between the voltage in the high voltage winding and that of the low voltage/tertiary winding.

Transformer

Device capable of changing the level of magnitude between input and output, providing galvanic insulation between them.

Turn

Spiral of a conducting wire around a magnetic nucleus.

Voltage

Difference in potential between two points. Measured in volts (V).

Winding

Set of spirals forming an electrical circuit associated with one of the voltages for which the transformer has been designed. Current conducting part of a machine.

Wye connection (Y connection)

Connection of windings in which the end of each phase winding of a three-phase transformer, or of each winding of the same voltage assigned to single phase transformers constituting a three-phase bank, is connected to a common point (neutral), the other end being connected to the terminal of the corresponding line.

Zig-zag connection (Z connection)

Connection of windings such that one end of each phase winding of a three-phase transformer is connected to a common point (neutral) and where each phase winding has two parts into which out-of-phase voltages are induced.